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NOTES ON THE SEASONAL MOVEMENTS AND HABITS OF SOME CAVE BATS

BY MARY J. GUTHRIE

[*Plate* 1]

A preliminary study, in 1928, of the ovarian egg of the bat (*Myotis* sp.?) indicated that this mammal was of great interest as a source of cytological material. Consequently, an extensive collecting program was started in the autumn of 1930 and continued until July 1, 1932. As it became apparent that little information was available about the specimens that were being secured, records were made in order that data on habits and seasonal movements would be at hand in connection with the gross and microscopic observations on the organs related to the reproductive function in the female. Thus it happened that what was primarily a cytological investigation became secondarily taxonomic and ecological.

No complete survey of the fauna of Missouri has been made, and no organized study of its cave inhabitants undertaken. The papers of Miller (1897), Hahn (1908), Howell (1921), Miller and Allen (1928), and Bailey (1928 and 1931) contain certain information about bats and their habits, but indicate that very little is known concerning these mysterious mammals. Consequently, an attempt was made, beginning in the autumn of 1931, to find out more about their habits and movements by making regular trips, usually fortnightly, to two limestone caves.

The fact that the two caves selected for collecting grounds were located on dirt roads often made the trips that were taken irrespective of weather conditions full of adventure. To my companions on these

expeditions, my grateful acknowledgments are expressed, especially to Dr. and Mrs. F. H. Woods, Dr. Katharine R. Jeffers, Miss Elizabeth L. Sawyer, and Mr. W. O. Nagel.

This study has been supported in part by a Grant-in-Aid from the National Research Council, to which acknowledgment is gratefully made.

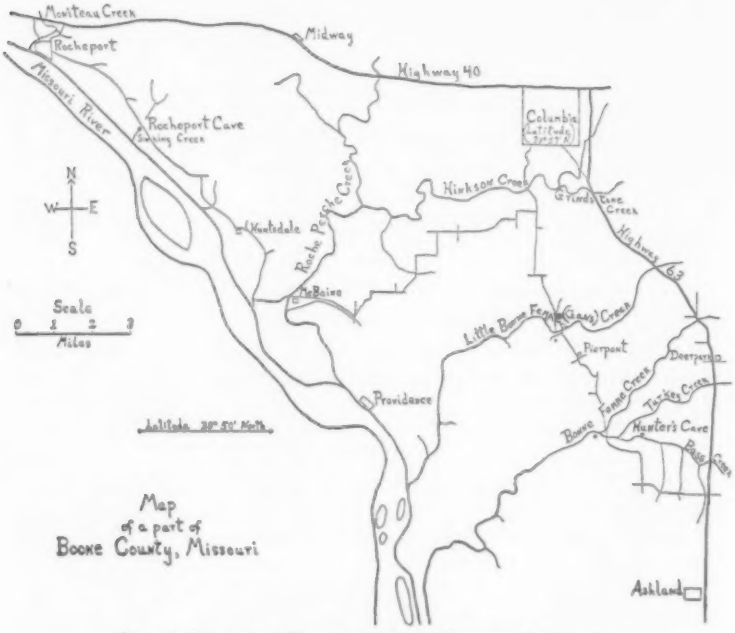


FIG. 1. MAP OF A PART OF BOONE COUNTY, MISSOURI

Contours traced from Reconnaissance Maps of the U. S. Geological Survey of 1886. The highways have been put in as they are at present, and only such side roads as lead to the caves have been entered in full; the junctions of other side roads are indicated as landmarks.

DESCRIPTION OF THE CAVES

The limestone caves from which collections were made are known as the Rocheport Cave and Hunter's Cave; both are in Boone County, Missouri (text-fig. 1). The Rocheport Cave is located about 10.5 miles almost due west of Columbia, while Hunter's Cave is about 9.5 miles in a southeasterly direction. Maps of these

caves (text-figs. 2 and 3) were made with the aid of a compass and tape measure; heights were estimated. The letters on the maps locate the regions referred to in the collection records.

The main entrance to the Rocheport Cave is at the base of a bluff that forms the head of a ravine, down which Sinking Creek flows toward the Missouri River about three-eighths of a mile away. This entrance (into "A" of text-figure 2) is quite large, measuring 85 feet across with an estimated height of 50 feet. The entrance passage extends north for 265 feet and is as wide as the entrance. Inward about 100 feet the ceiling drops to about 15 feet and has numerous fissures in it. To the left, at a distance of 200 feet, there is a room (B) with a very high ceiling that is always completely dark. The course changes to somewhat north of east down a dry passage (C) 68 feet long and 37 feet wide, where the stream has cut under the rock wall to the right. At noon during the summer the left wall of this passage is illuminated half way back. The course shifts to northeast for a distance of 127 feet along a passage (D) which is 31 feet wide. To the right of this passage is a section of some extent (E), where one must crawl; although the stream passes to the extreme right, most of this area is relatively dry. At the end of the passage "D," the way is blocked by a deep pool in the stream (F), and descent is made from a shallow shelf on the left under which the stream has cut. The course here is north of west for 64 feet. One can continue on this course for 125 feet into an area (G) with a low ceiling, where crouching and crawling are necessary and where a small stream is fed by abundant seepage. The main channel of Sinking Creek swings north of northeast, bounded on the right by a sloping ledge over which there is always a slight flow of water and a conspicuous crust of calcite. At 100 feet on this course the floor becomes more nearly level in a passage (H), 53 feet wide, which narrows to about 25 feet and then gradually widens. It is 293 feet along this course to the point of division into right and left forks (I). The left fork goes west of north, and within 50 feet the passage is entirely occupied by a deep pool of Sinking Creek. The right fork passes due east and is much narrower than the main passages have been. After 65 feet, one turns northeast for 100 feet and then goes east for 148 feet through a very moist cleft from 8 to 12 feet wide (J). A shallow stream covers most of the floor. The passage opens into a small room (K), where the course shifts to northeast for 60 feet. At this point, the main portion of the stream turns north for 20 feet and enters a low passage. To the right, a very narrow passage leads slightly north of northeast, turns south after 11 feet, and 15 feet farther along goes southeast; the swing is to the east after 35 feet.

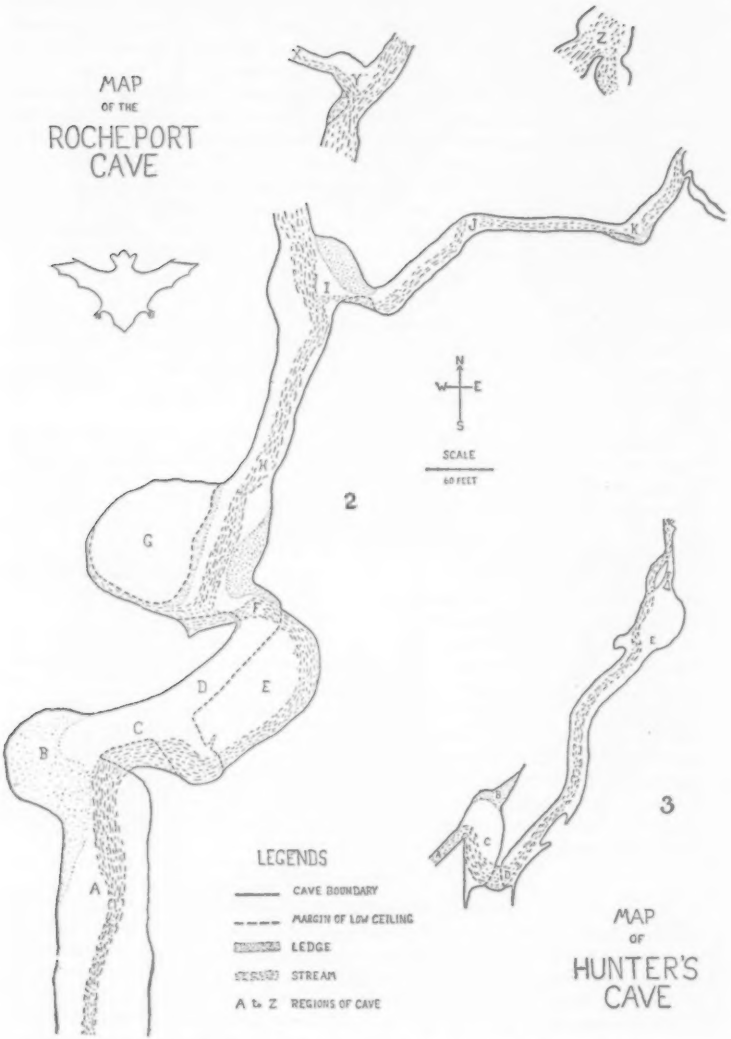
The Rocheport Cave is a rugged cave with much dirt infiltration from the creek, which is reputed to drain some 3,000 acres of farming land. Numerous rocks from the ceilings are scattered throughout, and in many places the ceilings are probably 40 to 50 feet high. The total distance from the entrance along the measured course to the end of the passage from room "K" is 1190 feet.

There are at least two other entrances to this cave. The one where Sinking Creek enters opens in a northeasterly direction at the foot of a bluff, with many small "holes" in its face and conspicuously undercut by the water. Although the stream is intermittent, the current after a heavy rain must be very strong. The entrance ("Z" of text-fig. 2) is divided into two parts: the left hand one is 16 feet across and 6 feet high; the right hand one, 22 feet wide and 4 feet high. If the

stream is not flowing, one can enter at the left for about 20 feet before the passage is completely occupied by a deep pool. At the right, however, an impassable pool always closes the way. These openings are somewhat more than a quarter of a mile from the entrance to passage "A." The other entrance ("X" of text-fig. 2) is at the base of a cliff that closes a rather short ravine. The passage, which one enters by crawling, is 13 feet wide and from 2 to 4 feet high. It runs south of east for about 35 feet to open into a room (Y) of the so-called left fork of the cave. The stream, which is shallow opposite the entrance, runs from east of north to south of west, and large, deep pools fill the passage in both directions. This "Y" room is probably somewhat nearer the entrance to the left fork at "I" than to the "Z" entrance. There are at least four sinkholes over the general course of the cave; but it has been impossible with the equipment available to correlate the surface and subterranean topography.

Although the cave is never dry, the broad high passages are much drier than some of the low ceilinged areas or the narrow high crevices where seepage is conspicuous. A considerable current of air must pass through this cave, and its temperature must reflect external changes to an appreciable extent. For example, on December 26, 1931, when the air temperature at the entrance to "A" was 13°C., readings in the main passage at "D" were 11.5°C. to 12°C. and in the region "E," 9.5°C. On February 20, 1932, when the temperature on the hill above the entrance was 2.25°C., passage temperatures varied from 5°C. at the beginning of region "D" to 12°C. on the ledge to the right of "H." In this connection it is interesting to note that Banta (1907) found that fluctuations in external temperature produced noticeable changes within Mayfield's Cave. Early one hot summer morning, while crawling toward the "X" entrance, I could feel a strong air current and detect odors from the ravine, but no leaves could be seen stirring through the opening. It seems quite probable that as evening approaches changing air currents may well be the stimulus that results in the swarming out of the bats.

In contrast to the Rocheport Cave, Hunter's Cave has an entrance which is 7.5 feet across and 8.5 feet high. It faces southwest at the base of a bluff, and a small stream flows from it, through a series of shallow pools, to join Bass Creek some 20 feet away. The entrance passage (A) appears almost man-made, so regular is it throughout its length of 48 feet. Exactly opposite the opening of the entrance passage into a room, there is a dirt ledge (B), about 8 feet above the level of the stream bed and running back 40 feet to end in a high fissure, 10 inches wide. The main passage turns south for 50 feet and continues 17 feet to another conspicuous fissure, 2 feet in width. The height of the ceiling in this passage (C) is about 20 feet. The front part of the cave is separated from the deeper parts by a short section, 3.5 feet high, 24 feet wide, and 13 feet long, where the stream swings around to a northeast course. Leading south from the beginning of the high passage (D) is another fissure, 2 feet in width. The passage "D" is 18 feet in width and continues northeast for 98 feet, shifts to east of north for 71 feet, then to northeast for 100 feet. Its characteristics are essentially the same throughout: a shallow stream, gravel floor, high fissured ceiling, and abundant seepage. At the end of passage "D" there is a small irregular room (E) where the ceiling to the left is very high, as if a sinkhole might have been rather recently formed. From this room, the course is north for 41 feet to a point where the stream diverges to the left through a very low passage. One can crawl through a passage "F" on



FIGS. 2 AND 3. MAPS OF THE ROCHEPORT CAVE AND OF HUNTER'S CAVE

the right for 14 feet in a northeasterly direction and then pass for 48 feet north along a higher passage, to which the stream returns. This is the limit of progress, 483 feet from the entrance. The stream fills a low passage to the left; and to the right, a tunnel about 2.5 feet in diameter leads northeast.

This cave is probably quite long, if one can judge from its low temperature and conspicuous air currents. On a hot day, the cold air current emerging from this cave is very noticeable, and again the effect of outside temperature upon that of the cave must be considerable. On February 28, 1932, when the temperature at the entrance was 11.25°C., the temperature of the passage "D" about half-way in was 12.0°C. The moisture content of the greater part of this cave is quite comparable to that of the passage "J" of the Rocheport Cave. No information is at hand about other entrances or the source of the small stream.

METHODS USED

Since the primary aim of collections was to get specimens for cytological preservation, shooting was the least used of the methods of collection. However, it was necessary to shoot when bats were on the high ceiling of "B" in the Rocheport Cave or in other inaccessible places. Some shooting was also done outside Hunter's Cave.

During the hibernation period, when the bats could not be reached with the hands or with a net, they were taken with a very satisfactory device constructed by Dr. Woods and dubbed a "bat snatcher." It consisted of a pair of large forceps fastened at the end of a bamboo pole and manipulated by means of a wire leading to a hinged handle after the fashion of a tree clipper. When the bats are active, they fly when the light is thrown on them and cannot be taken in place. Netting was then the method used. If one stands, without a light, in a narrow or high part of a passage and rapidly moves a net back and forth as the bats fly out at dusk they can be obtained in considerable numbers.

With these several methods, bats were collected during the months when they were in the caves. Sometimes a clump would be counted, and the sex of the individuals determined without taking them to the laboratory. Such bats were always brought to a high state of activity by shaking before being released. Usually, specimens were taken to the laboratory where identification was made and records on sex and age taken. Males were sometimes kept with the females for observation, sometimes released. The females were killed and studied with reference to the reproductive cycle. The report of such observations is to be published elsewhere. A cytological study of the reproductive system and related glands is in progress.

OBSERVATIONS

To one for whom a bat had previously been only a bat, it was somewhat surprising to find six species occupying the caves visited (Plate 1). Four species of the widespread genus *Myotis* were taken: *M. lucifugus lucifugus*, *M. grisescens*, *M. keenii septentrionalis*, apparently rare in this region, and *M. sodalis*, not reported before from Missouri. These forms were identified with the aid of Miller and Allen's monograph (1928) and a loan of skins and skulls from the Field Museum, for which I am greatly indebted. Identifications were checked by Mr. Gerrit S. Miller, Jr., of the United States National Museum, and by Mr. C. C. Sanborn, of

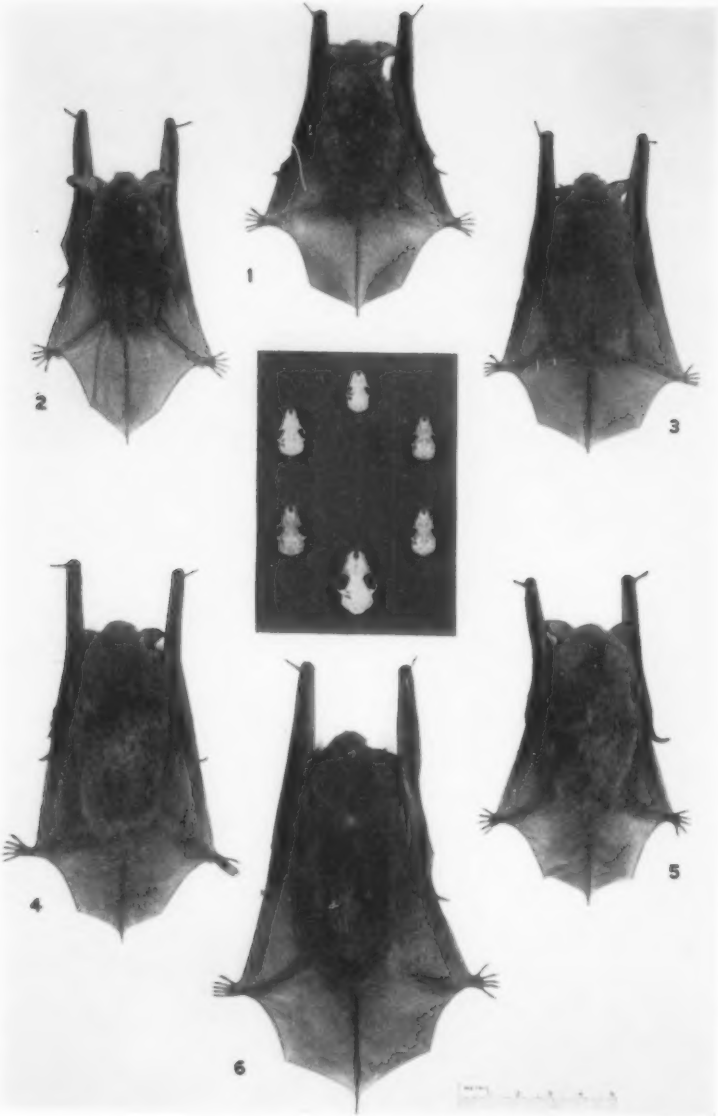


FIG. 1. Pipistrellus subflavus. FIG. 2. Myotis keenii. FIG 3. Myotis sodalis. FIG. 4. Myotis grisescens. FIG. 5. Myotis lucifugus. FIG. 6. Eptesicus fuscus. Skulls in same relative position as skins. × 0.5

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the Field Museum. To both of these gentlemen, my appreciation is expressed. In addition to the species of *Myotis*, two other species occurred: *Pipistrellus subflavus subflavus* and *Eptesicus fuscus fuscus*. Although *Lasiurus borealis borealis* must be fairly common in this region, since specimens are occasionally brought to the laboratory, it has not been recorded from these caves.

Not only are the species separable by their diagnostic morphological characters, but each has habits that are distinctive when compared with those of its associates. Some of these features of behavior have not been carefully compared. While none of these bats are particularly docile when active, I have seen no tendency to attack except when a specimen is held. They crouch or scuttle away if one's hand rapidly approaches them. Within the cages they occasionally fight one another, but I have not seen altercations between representatives of different species caged together. *Eptesicus* appears to have the most resentful disposition, although its size and the length of its teeth may have exaggerated my impressions.

One observation on the habits of *Myotis grisescens* outside the caves was made. On June 24, 1932, a lactating female was wounded by Dr. Woods near the entrance of Hunter's Cave. As he picked it up, it made cries that were not different, so far as we could discern, from the usual sounds made when these bats are disturbed. However, several dozen bats swooped from all directions and flew close to but did not touch Dr. Woods. This response was repeatedly demonstrated since the flying bats dispersed as soon as the cries ceased. Their return was practically instantaneous when the cries were again induced. Nothing of this sort has ever been noted in the caves. [Analogous behavior of *Artibeus jamaicensis* in a Haitian cave has been recorded by Miller, Smithsonian Misc. Coll., vol. 81, no. 9, p. 9. March 30, 1929.—Ed.]

Pipistrellus and *Eptesicus* can be distinguished from *Myotis* by the sounds they make when captured or disturbed. *Eptesicus fuscus* and *Myotis grisescens* have very characteristic body odors, probably from the secretions of the facial oil glands. The degree and kind of external parasitism are also different. *M. grisescens* is always heavily parasitized with a species of tick and is the least careful of its coat. In the laboratory, specimens become covered with various kinds of food without making any particular effort to clean themselves. *M. sodalis* has few parasites but usually two ticks in its rectum. It is relatively cleanly in habit, while *M. lucifugus* takes excellent care of its hair. A few fleas are the only parasites noted in this last species. *Pipistrellus* is without parasites so far as my observations go and is very tidy in its habits. Bats recently collected lick and scratch off the mud and comb and smooth their hair before becoming quiescent in the cages.

While bats drink during flight under natural conditions, they readily learn to lap water from a dish in a cage. They eat almost anything offered, taking it from the floor of the cage or from a finger with no indication of fear unless they are touched. Various mixtures of food were given, including muscles and glands of rats, calves' liver and brains, spinach, carrots, graham flour, and dried milk, No combination of these sustained life for long if the bats were active, although they ate quite a bit of some offerings.

Certain characteristics of position in the caves are most conspicuous. *Eptesicus* was found only at the Rocheport Cave and, with very few exceptions, in the large, relatively dry entrance chamber. Individuals are always isolated when

they hang, although when they crawl into crevices, there may be two or three together. *Pipistrellus* is also always isolated and has not been found in crevices. Specimens occur in very moist places and are beautiful objects as the light flashes on them when they are covered with droplets of water. Some appear frosted under these conditions and doubtless are the "white" bats sometimes reported by casual observers. *Myotis lucifugus* also likes moist places, although it is less frequently taken from seepage regions than is *Pipistrellus*. *M. lucifugus* hangs isolated or in small groups up to possibly 25 or 30 and takes advantage of all available small cavities, where a number may be closely packed, resting on their ventral surfaces. On the other hand, *M. sodalis* is rarely found in such cavities or in small groups but hangs in relatively dry places in masses that sometimes contain several hundred. A few *M. grisescens* may be found together in small crevices in the entrance chamber at Rocheport at the time when this species returns to the cave in the summer. Usually, they hang in very large groups; some I have estimated as containing from 500 to 600 individuals. This species penetrates deeper into the caves as the summer progresses and is not found in the driest parts nor where seepage is abundant.

Since *Myotis grisescens* is the only summer resident, it is the only one observed with young. Specimens taken with young dislodged them when caged and were for the most part entirely unmindful of them, although the young called repeatedly and made efforts to attach themselves when old bats passed near. One female took a young one, but it was not certain that any particular one was selected. It was thought that perhaps handling the young had resulted in their desertion, but one born in the cage and untouched was left almost immediately. Of course, conditions were not normal, but the bats were not starving; they were fat when killed. In this species, at least, "maternal instinct" would not appear to be pronounced. This particular species does not carry its young when feeding but leaves them in the cave. Many lactating specimens were netted as they left the cave in the evenings, but not one had a young one with her. If, however, a group is disturbed in the daytime and netted, some females are carrying young, some are not. Apparently there are periods of suckling and periods when the young are pushed off. In some cases, young fell off as the parents flew; and after a relatively short flight, females carrying young seemed fatigued and were loath to fly even when a light was flashed on them.

Segregation of sexes was observed in *Myotis grisescens*, as will be apparent from the specific collection records. Migration of young males and young females occurs separately and with only a very small contingent of old companions in each case. Pregnant and lactating females are found together in the summer with very few of the immature females characteristic of this species.[1] Such females are more commonly found with the males and in an entirely different part of the cave. In the case of *Pipistrellus* and *Eptesicus*, males are resident in the caves for a considerable period after the females have left. Among the hibernating forms, males and females are found together.

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[1] In *M. grisescens*, many, if not all, females do not mature eggs in the spring of their second year. These young females are called immature during this second spring and summer. Females of the other species observed mature eggs at the close of their first winter.

Further observations can be better related to the specific collections of the several species, which will be listed in sequence. The collections of March, April, and May, 1931, do not have the detailed records taken for later collections but are interesting for comparison with the comparable period in 1932.

March 5, 1931, Rocheport. Large mass of *Myotis sodalis* under "E."

March 9, 1931, Rocheport. Large mass of *M. sodalis* under "E."

March 16, 1931, Rocheport. No *M. sodalis* found; *M. lucifugus* in crevices along "D."

March 23, 1931, Rocheport. No *M. sodalis* present; *M. lucifugus* in crevices and on ceiling of "D."

March 30, 1931, Rocheport. Two large clumps of *M. sodalis* under "E."

April 6, 1931, Rocheport. *M. sodalis* found at "E."

April 12, 1931, Rocheport. No *M. sodalis* and very few *M. lucifugus* present in any region. Some *Pipistrellus* observed along passage "J."

April 20, 1931, Hunter's. Few *M. lucifugus* and *M. grisescens* females found.

May 4, 1931, Hunter's. *Pipistrellus* and only one *M. lucifugus* taken.

May 15, 1931, Rocheport. *Pipistrellus:* 7 males, no females present.

May 26, 1931, Hunter's. *Pipistrellus:* 23 males, no females present.

June 10, 1931, Rocheport. No bats found.

June 20, 1931, Rocheport. *M. grisescens:* numerous females with young observed in crevices in ceiling of "A" and in a large cluster on ceiling of "B."

June 23, 1931, Hunter's. *Pipistrellus:* 2 males found.

June 28, 1931, Hunter's. *M. grisescens:* 2 immature females and some males netted.

July 1, 1931, Rocheport. *Pipistrellus:* 1 male netted. *M. grisescens:* 1 pregnant, 13 lactating, 4 immature females netted.

July 28, 1931, Rocheport. *M. grisescens:* 24 females netted; 10 lactating, 7 post-lactation, 5 immature, 2 season's young.

August 12, 1931, Rocheport. *M. grisescens:* 10 females netted; none lactating, 6 post-lactation, 2 immature, 2 season's young.

September 4, 1931, Rocheport. *M. grisescens:* 9 females netted; 5 old, 4 young.[2]

September 22, 1931, Rocheport. *M. grisescens:* 40 females, 6 males netted; old and young of both sexes.

October 9, 1931, Rocheport. *Eptesicus:* 2 males shot from side wall of "B;" not activated by light. *M. sodalis:* 1 female and 5 males, all young, shot from ceiling of "D;" not activated by light; not more than 3 observed in any cluster. *M. grisescens:* several large active clusters along "D" and in "Y," flew when lighted or when shooting occurred; 6 young males netted.

October 11, 1931, Rocheport. *Eptesicus:* 3 inactive males taken from walls of "B." *Pipistrellus:* all inactive and isolated in very moist places; females (2 young, 4 old), 1 over stream under "E," 5 in "J;" 6 males (4 young, 2 old), all in "J." *M. sodalis:* inactive and in clusters of 2 to 4; 1 young female from "D;" 16 young males chiefly from "D," some from "H." *M. lucifugus:* 1 young male. *M. grisescens:* large active clusters; netted in "D," 2 young females and 26 males (16 young, 10 old); netted in "K," 3 young females and 49 males (22 young, 27 old).

[2] Bats in which any wear on the teeth could be observed with a hand lens are classed as old; those with no wear, as young.

October 18, 1931, Hunter's. *Pipistrellus:* inactive and isolated along passages "C" and "D" and in fissures; 2 females and 10 males. *M. grisescens:* large group on ceiling in "D," inactive when lighted but some chattering; no females, 182 males; 12 examined (5 young, 7 old).

October 19, 1931, Rocheport. *Pipistrellus:* isolated in "J," inactive; 1 young female, 4 males. *M. sodalis:* 8 groups containing from 10 to 50 each (both sexes) in "K," some isolated along "H;" some movement but no flying when lighted, some chattering; 26 females (only 1 old), 6 young males. *M. lucifugus:* 1 young female, 1 young male. *M. grisescens:* large group on ceiling of "F," rather inactive; 1 old female, 158 males, 12 examined (4 young, 8 old).

October 28, 1931, Rocheport. *Eptesicus:* 4 isolated males on walls of "B," inactive. *Pipistrellus:* isolated in "I" and "J," inactive; 3 females (only 1 old), many males. *M. sodalis:* small groups on ceiling of "H," larger clusters at entrance to "J" and in "K," some flew when lighted; 35 females (only 5 old), 63 males (only 6 old). *M. lucifugus:* 1 young female and 1 old male taken in "H." *M. grisescens:* no groups present; 2 old males, inactive.

November 8, 1931, Rocheport. *Eptesicus:* 2 isolated old males from small cracks in walls of "A;" 3 isolated females (2 young, 1 old) hanging deep in "D;" all inactive. *Pipistrellus:* 1 young female, inactive. *M. sodalis:* scattered ones and groups in "D" and "K," some flew when disturbed by flash light; groups counted gave 19 females (4 old) and 14 young males, 49 females and 63 males, 20 females and 19 males. *M. lucifugus:* 3 females (1 young, 2 old) and 2 young males. *M. grisescens:* 2 old males taken in groups with *M. sodalis*.

November 21, 1931, Rocheport. *Eptesicus:* 1 inactive, old female from wall of "B." *Pipistrellus:* isolated, inactive; hanging under "G" where there is much seepage; 4 young females, 5 young males. *M. sodalis:* at least a dozen groups of approximately 100 bats each, also some scattered in "D," few small groups in "K," some activity when flashed; one group contained 49 females and 52 males, a small group had 7 females and 17 males; specimens checked for age showed 36 young to 17 old females and 51 young to 14 old males. *M. lucifugus:* isolated and twos and threes, inactive, in cracks under "G;" 5 females (only 1 old), 11 males (only 5 old). *M. grisescens:* in groups with *M. sodalis;* 2 females (1 old), 1 old male.

December 3, 1931, Rocheport. *Eptesicus:* isolated, inactive, in cracks in "A" and walls of "B;" 4 females (only 1 old), 2 males (1 old). *Pipistrellus:* none found. *M. sodalis:* small, inactive groups in "D," none counted but only young observed. *M. lucifugus:* small groups in cracks along "D," some chattering; 3 females and 7 males in one group, 3 females in another; of 8 females brought to the laboratory, 5 were old; fecal matter contained some insect remains and bat hairs. *M. grisescens:* 1 old female found inactive on wall of "A."

December 12, 1931, Rocheport. *Eptesicus:* isolated, inactive, in small cavities in walls of "A," one female hanging in light region of "A," one female hanging on wall of "F;" 5 females (3 old, 2 young) and 3 males (2 old, 1 young). *Pipistrellus:* isolated, inactive, hanging at "I" and in "J;" 2 young females, 9 young males. *M. sodalis:* groups, inactive, in "D;" two masses counted together contained 36 females and 61 males; only 5 old females in a sample of 21. *M. lucifugus:* isolated or twos and threes, inactive in cracks under "G," one female in group of *sodalis*; 3 females (1 old, 2 young), 10 males (7 old, 3 young). *M. griesescens:* none found.

December 12, 1931, Hunter's. *Pipistrellus:* isolated, inactive, in "C" and "D;" 10 females (only 2 old), 37 males. *M. sodalis:* 2 males (1 old) taken with *M. lucifugus*. *M. lucifugus:* isolated on ceiling of "B," small groups in "C," few isolated in "D," inactive; 25 females (only 9 young), 4 males.

December 26, 1931, Rocheport. *Eptesicus:* isolated, inactive, hanging in "B" and one in "D;" 1 old female, 4 males. *Pipistrellus:* isolated, inactive, hanging near stream under "E," under "G" and in "J;" 1 young female, 3 males (2 old, 1 young). *M. sodalis:* 2 large groups of several hundred each under "E," few scattered in "D" and 4 in crack in "A;" part of group removed and counted had 48 females (only 12 old) and 62 males (only 12 old). *M. lucifugus:* isolated and small groups, hanging and in crevices along "D" and "H" and under "G," inactive; 30 females (only 9 young), 26 males (only 9 young).

January 16, 1932, Rocheport. *Eptesicus:* found in new location in cracks and hanging from ceiling of deeper part of "A," some in considerable light, one deeper in "D," inactive and isolated; 2 females (1 old), 5 males (3 old, 2 young). *Pipistrellus:* found in places where none had been seen for weeks, few in "D," many in "J," isolated, inactive; 5 females (4 old, 1 young), 15 males (11 old, 4 young). *M. sodalis:* no groups present, one taken hanging and one in crack in "A," others in "D," isolated and inactive; 2 females (1 old), 4 males (3 old). *M. lucifugus:* small groups in recesses along "D" and "H," some activity, one flew from "snatcher;" 16 females (only 3 young); 27 males (only 11 young).

February 6, 1932, Rocheport. *Eptesicus:* 2 males in crevices in "A." *Pipistrellus:* isolated, inactive, one in "D," others in "J;" 3 females (1 old), 2 young males. *M. sodalis:* 2 groups in "D," larger contained 30 females (13 old) and 36 males (19 old), inactive. *M. lucifugus:* small groups, hanging and in cavities along "D" and "H," few flew when lighted; 23 females (13 old, 10 young), 28 males (15 old, 13 young) were counted; 3 pairs taken.[3] *M. keenii:* not identified at cave and exact place of collection therefore unknown; 2 old females and 1 young male.

February 20, 1932, Rocheport. *Eptesicus:* 1 male hanging on wall of "B." *Pipistrellus:* only 2 males (1 old) seen, one in "D," one in "J." *M. sodalis:* scattered, inactive in "D;" 2 young females, 5 males (2 old, 3 young). *M. lucifugus:* conspicuous influx of young with very noticeable sooty tinge to ears, membranes and hair; small groups in cracks and hanging in "D" and "H," inactive; 43 females (20 old, 23 young), 65 males (27 old, 38 young).

February 28, 1932, Rocheport (did not collect beyond "F"). *Eptesicus:* 1 young male hanging in "A." *Pipistrellus:* one hanging on side wall of "A," others in "D" and under "E;" inactive; 2 females (1 old), 5 males (2 old, 3 young). *M. sodalis:* inactive, isolated, 4 in "A," others in "D;" 5 females (1 old, 4 young), 3 young males. *M. lucifugus:* some activity when lighted, hanging and in crevices in front part of "D" where they have not been before; 27 females (only 6 old) 28 males (11 old, 17 young); 4 pairs taken.

February 28, 1932, Hunter's. *Pipistrellus:* isolated, only one flying, others inactive, one hanging in light in "A," others in "C" and "D;" 11 females (8 old, 3 young), 43 males (of 13 that were examined 8 were old, 5 young). *M. sodalis:* isolated, inactive, in "C;" 1 old female, 1 young male. *M. lucifugus:* inactive,

[3] When a male and female were taken side by side and apart from others, they were entered as a pair, although copulation was not observed.

isolated, small groups hanging and in cracks in "B" and "C," and two taken from "A;" 39 females (13 old, 26 young), 37 males (17 old, 20 young); 2 pairs taken.

March 25, 1932, Rocheport. *Eptesicus:* 1 young male hanging deep in "A." *Pipistrellus:* inactive, isolated from "D" to "K;" 4 females (1 old, 3 young), 18 males (11 old, 7 young). *M. sodalis:* two hanging in "A," others in "D;" 3 females (1 old, 2 young), 5 males (2 old, 3 young). *M. lucifugus:* small groups and isolated, hanging and in crevices throughout "D," few flying when lighted; 38 females (17 old, 21 young), 54 males (31 old, 23 young).

April 2, 1932, Rocheport (did not collect beyond "F"). *Eptesicus:* 1 old male hanging in "B." *M. lucifugus:* numbers on ceiling of "D" seemed reduced; collections from crevices in "D" yielded 8 females (7 old, 1 young) and 7 males (2 old, 5 young).

April 2, 1932, Hunter's. *Pipistrellus:* 12 or more seen but not collected. *M. lucifugus:* numbers obviously reduced, in crevices in ceiling of "B," along walls of "C," few isolated in "D;" 12 females (7 old, 5 young), 25 males (7 old, 18 young). *M. grisescens:* 1 immature female in "C."

April 16, 1932, Rocheport. *Pipistrellus:* not carefully searched for but 1 old female and 1 old male taken. *M. sodalis:* 1 young female at "F." *M. lucifugus:* numbers reduced, some bats in flight, small groups on ceiling and in crevices in "D;" 6 females (4 old, 2 young), 5 males (4 old, 1 young).

April 30, 1932, Hunter's. *Pipistrellus:* isolated and active, flying when touched, in "C" and "D;" 6 females (3 old, 3 young), 5 males (only 1 old). No *M. sodalis* or *M. lucifugus* present. *M. grisescens:* group of about 10 on ceiling of "B;" mass of possibly 500 on ceiling in "D" with small group of 6 nearby, all inactive; of those collected, 28 were females (21 immature) and 6 were males (only 1 old); insect remains in feces and no subcutaneous fat.

May 1, 1932, Rocheport. *Pipistrellus:* only 3 males seen and taken. *M. lucifugus:* only 1 young male seen and taken; no indications of feeding. *M. grisescens* isolated and small groups at "I;" 6 females (only 1 old), 5 young males.

May 2, 1932, Hunter's. *Pipistrellus:* few present but number not recorded. *M. grisescens:* only 3 immature females found.

May 17, 1932, Hunter's. *Pipistrellus:* isolated, inactive, hanging in "C" and "D;" no females, 35 males (13 old, 22 young); insect remains in feces, subcutaneous fat scant. *M. lucifugus:* no females, 1 old male in "C;" insect remains in feces. *M. grisescens:* no females, 1 old male in crevice in "D;" insect remains in feces.

May 19, 1932, Rocheport. *Pipistrellus:* one seen on ceiling of "H," 2 over water at "I;" only 1 young male could be collected; insect remains in feces. No other bats found.

May 30, 1932, Hunter's. *Pipistrellus:* 30 seen in "C" and "D;" 18 collected were all males; 3 males shot at entrance. Few larger bats flying too late for shooting.

June 19, 1932, Rocheport. *Eptesicus:* one old male hanging in "D." *M. grisescens:* active, young chattering, in cracks along ceiling of "A" and large group on ceiling of "B;" no males present; 28 females brought to laboratory, 27 with much wear on teeth; 3 were pregnant, 1 immature, others lactating; young ranged in total length from 46 to 69 mm.

June 24, 1932, Hunter's. *Pipistrellus:* 1 young male shot at entrance. *M.*

TABLE 1

Departure from normal temperature (°F.)

DATE	1931												1932					
	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June
1	−2	+11	−3	−9	0	−7	+12√	+10	+1	+7	−5	−1	+9	+5	+15	+11	−6√	−3
2	+10	+18	−1	+4	−2	+1	+8	+1	−2	+9	+5	−1	+2	+15	+9	+16√	−4√	+5
3	+14	+21	−1	−6	−5	+6	+4	−1	−4	+10	+10	+2√	−4	+2	+3	+4	+11	+6
4	+12	+9	−4	−13	−1√	+8	+2	+3	+4√	+11	+1	+4	+3	−9	−2	+16	+15	+6
5	+1	+16	+1√	−9	−7	+8	−7	0	+6	+15	−2	+2	+14	+8	−16	+13	+13	+8
6	−3	+23	−5	−4√	−17	−3	−4	+3	+11	+17	−5	+3	+2	+15√	−24	+23	+15	+7
7	+2	+17	−11	+8	−12	−9	−1	+10	+13	+10	+13	+1	+2	+19	−24	+6	+12	+7
8	+3	+12	−10	+16	−9	−7	−3	+11	+11	0	+20√	+1	−2	+5	−27	−2	+8	+3
9	+6	−1	−11√	+3	−16	+3	−1	+1	+12	0√	+22	+5	−6	+22	−26	−2	0	+1
10	+5	−3	−10	+3	−12	+4√	−5	−9	+10	+14	+10	+15	+7	+40	−23	−1	−4	−2
11	+9	+14	−4	+11	−11	+3	0	−12	+10	+7√	+16	+16	+15	+24	−17	−3	−1	+1
12	−1	+16	+1	+12√	−9	0	+3	−12√	+8	−6	+17	+8√	+23	+10	−19	−8	−1	+1
13	−9	+3	+9	+12	−5	+2	+7	−10	+12	+3	+9	+1	+21	0	−11	−1	+4	0
14	−15	−4	+2	+13	−3	+5	+11	−4	+15	+2	+22	0	+7	+1	−16	−8	+12	−1
15	−3	+9	−8	+15	+4√	+3	+11	−2	+19	−3	+21	+5	+1	+3	−1	+1	+10	−3
16	+11	+8	−7√	+10	+12	+3	+9	+2	+16	0	+25	+6	+9√	+14	+6	+3√	−6	0
17	+9	+8	+2	+8	+12	+3	+7	+1	+15	−6	+17	+9	+15	+4	−4	−2	−6√	+10
18	+7	+3	+6	+10	+5	+8	+9	−2	+11	−4√	+12	+21	+7	+1	0	−4	−3	+8
19	+4	+3	−5	+12	−9	+8	+7	0	+17	+2√	+14	+20	+16	+3	+8	−1	−1√	+2√
20	+1	+5	−6	−3√	−14	+8√	−3	−1	+16	+9	+14	+18	+26	+1√	−4	+6	+1	−2
21	+2	+7	−5	−17	−15	+7	+4	−3	+13	+10	+13√	+18	+19	+7	−13	+13	+4	−1
22	+6	+8	−1	−14	−13	+11	+7	−6	+12√	+14	+21	+17	+5	+3	−12	+12	+3	+2
23	+14	+6	+4√	−17	−11	+11√	+5	−2	+8	+14	+25	+23	+1	+6	−7	+8	+2	+3
24	+25	+6	−4	−11	+3	+10	+1	+2	−4	+18	+4	+16	+1	+13	+6	+11	+8	+4√
25	+15	+10	−4	−10	+7	+10	+1	0	+3	+8	−5	+9	+7	+23	+14√	−3	+11	+4√
26	+13	+7	−5	−16	+3√	+11	+3	−1	−10	+12	−7	+15√	+7	+20	+4	−15	0	+1
27	+15	+15	−8	−13	+10	+11	+5	+4	−8	+8	−6	+13	+11	+20	−1	−13	−10	−1
28	+15	+8	−17	−6	+9	+13√	+12√	−4	−4	+1√	−2	+9	+22	+20√	+3	−3	−13	−5
29	+15		−10	+5	+4	+12	+11	−3	0	−5	0	+16	−4	+18	+14	0	−6	0
30	+23		−8√	−4	−9	+14	+9	+4	+2	−7	+1	+26	−17		+2	−2√	−3√	+6
31	+11		−7		−9		+10	+5		−6		+18	−7		−7		+1	
Mean...	+6.9	+9.3	−4.2	−0.2	−3.9	+5.2	+4.1	−0.6	+7.0	+5.4	+9.5	+10.2	+7.0	+10.8	−5.6	+2.5	+2.0	+2.3

Explanation: Compiled from the monthly meteorological summaries issued by the U. S. Department of Agriculture Weather Bureau Station at Columbia, Missouri. Days on which collections were made are indicated by a √ after the temperature record.

TABLE 2

Maximum and minimum temperatures (°F.)

DATE	1931																								1932											
	January		February		March		April		May		June		July		August		September		October		November		December		January		February		March		April		May		June	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1	42	13	54	27	37	30	50	30	71	50	74	51	101	√76	98	76	80	66	77	62	51	36	44	29	43	35	44	25	56	47	81	40	62	√45	71	62
2	51	29	64	30	43	28	67	42	69	48	82	58	90	77	90	66	78	63	81	63	68	41	46	26	36	29	50	38	51	40	82	√51	71	√40	86	62
3	53	35	67	34	42	31	48	41	68	45	87	66	88	72	87	64	78	59	84	60	71	46	43	√33	29	24	38	24	41	38	66	42	85	59	85	66
4	48	36	48	28	44	24	41	34	76	√45	87	70	87	70	90	69	88	√64	82	64	60	38	43	37	37	29	29	12	43	30	80	54	88	63	87	66
5	36	26	59	31	42	√36	54	30	64	45	87	70	77	61	82	72	91	65	87	67	59	34	46	31	50	37	51	23	30	13	81	46	85	62	89	68
6	30	24	57	48	36	30	61	√33	50	38	73	62	86	57	91	69	91	73	87	68	58	27	46	30	37	27	54	√34	19	8	84	62	86	65	89	67
7	38	25	51	41	31	25	76	45	68	33	69	54	86	64	98	76	94	73	81	61	74	47	44	29	37	28	62	33	22	8	70	47	81	66	88	67
8	36	30	47	35	33	25	83	54	58	48	78	49	85	63	98	79	93	70	65	54	80	√52	40	33	34	22	41	28	15	8	61	40	80	59	82	65
9	45	26	35	23	36	√22	66	46	50	43	84	64	86	65	88	67	93	71	69	√51	75	60	45	33	31	16	70	34	19	10	64	38	68	55	80	65
10	40	29	37	17	40	19	69	44	54	45	85	√66	86	59	76	61	92	69	87	62	65	46	55	43	45	27	77	63	25	9	60	44	64	52	78	63
11	42	33	54	35	45	28	77	51	57	48	84	66	90	64	72	58	90	69	75	√56	73	49	59	42	54	35	68	39	28	18	59	42	75	50	84	62
12	33	24	51	42	51	32	78	√54	62	45	81	64	93	68	75	√53	88	68	57	49	72	53	50	√35	56	48	53	27	26	18	57	35	76	47	85	61
13	28	11	43	26	60	41	79	53	70	47	85	64	96	71	80	53	91	71	68	54	56	50	42	28	63	38	40	22	43	16	68	38	84	50	83	61
14	22	5	36	18	54	35	77	58	76	46	87	69	99	77	84	59	94	73	68	52	78	55	41	25	38	33	35	30	34	18	61	33	90	62	80	63
15	38	13	54	28	39	28	82	57	82	√53	84	69	99	76	86	63	96	79	63	46	75	55	50	26	34	27	39	31	56	26	73	39	87	60	80	61
16	43	36	44	36	45	√25	72	58	88	63	84	67	97	76	99	66	94	74	68	46	78	58	49	29	46	√31	55	38	58	39	62	√53	66	50	84	62
17	40	36	44	35	61	29	74	55	89	62	88	65	94	73	83	71	91	75	60	41	68	51	54	29	52	36	44	27	47	31	61	48	71	√45	95	71
18	42	31	39	33	59	39	80	52	79	61	91	73	97	74	80	69	85	71	64	√40	59	49	65	42	45	28	41	26	56	30	63	40	75	49	90	73
19	40	26	40	33	44	34	77	60	61	51	93	70	92	77	83	67	93	74	70	√44	61	51	58	47	58	32	42	29	68	36	63	47	78	√50	85	√66
20	36	24	46	30	42	33	67	√42	58	44	91	√72	79	68	82	67	93	73	77	50	64	49	57	42	64	46	41	√26	50	30	74	52	82	50	78	66
21	42	20	51	31	42	37	42	38	61	41	92	70	90	72	81	63	92	66	77	52	65	√44	58	42	59	37	47	35	37	27	82	58	82	59	80	66
22	46	24	44	40	56	33	54	34	61	45	95	75	96	71	83	55	90	√65	76	60	72	52	60	38	37	32	45	29	41	25	78	62	80	58	86	66
23	58	28	42	38	57	√42	46	36	69	41	97	√75	90	73	87	58	82	65	71	63	73	57	63	47	35	26	50	29	46	32	70	62	83	54	88	68
24	66	41	49	33	47	37	51	43	84	56	96	74	87	68	87	65	66	59	81	61	57	30	56	38	38	21	61	34	66	38	80	58	90	60	89	√69
25	53	34	54	36	53	31	50	45	86	63	97	73	89	68	85	64	79	56	69	50	42	26	51	30	45	28	73	43	73	√48	63	47	87	68	88	√70
26	52	31	53	31	46	38	49	37	83	√57	97	74	92	69	85	61	61	49	79	50	33	32	55	√36	40	33	68	42	59	43	49	40	73	61	81	71
27	56	33	62	40	44	34	57	35	88	67	99	74	96	69	88	67	68	44	72	49	34	32	50	38	50	29	67	45	54	38	57	34	66	49	82	67
28	58	29	52	37	34	28	70	36	88	66	99	√76	102	√76	78	60	74	46	64	√40	37	34	45	35	64	38	72	√40	63	39	69	42	67	43	81	60
29	54	34			44	31	76	51	81	62	100	75	102	74	85	54	75	52	50	42	39	36	54	39	38	12	64	44	76	47	66	52	72	53	90	63
30	63	41			46	√35	61	52	66	53	101	78	101	71	89	65	79	51	44	42	42	35	09	51	19	5			63	36	67	√49	77	√55	92	73
31	49	32			47	36			71	48			96	78	90	67			47	41			54	43	32	12			54	30			76	65		
Mean...	44.5	27.7	49.2	32.7	45.2	31.5	64.5	44.9	70.6	50.3	88.2	67.8	91.9	70.2	85.5	64.6	85.3	65.1	71.0	52.9	61.3	44.2	51.1	35.7	43.4	29.1	52.4	32.8	45.8	28.3	68.4	46.5	77.6	55.0	84.5	65.7

Explanation: Compiled from the monthly meteorological summaries issued by the U. S. Department of Agriculture Weather Bureau Station at Columbia, Missouri. Days on which collections were made are indicated by a √ between the temperature records.

grisescens: some flew from "F" within 15 minutes after sunset and in another 15 minutes were emerging in great numbers, clustered along walls of "D" and chattered on way out; also came from fissures leading from "B," "C," and "D;" 5 shot at entrance, some netted; 2 females (1 immature, 1 lactating), 7 males (5 old, 2 young).

June 25, 1932, Rocheport. *M. grisescens:* large group on ceiling of "B," young chattering, old flying when flashed; 14 females netted, 1 pregnant, 1 immature, 12 lactating (11 very old); no males taken. Shooting at the "Z" entrance brought down 2 lactating and 2 immature females and 1 old male; a considerable number emerged from "Z" but not so many as from the entrance to "A." *M. lucifugus:* 1 young male with partially descended testes shot at "Z."

DISCUSSION

Since Merriam (1887) and Miller (1897) gave conclusive evidence for migrations of bats based on their occurrence at certain seasons in regions not occupied at other seasons, references to migration have been frequent in the literature. Banta (1907) observed fluctuations in numbers of *Pipistrellus subflavus* in Mayfield's Cave (latitude given as 39.5°N.) during April. Hahn (1908) noted differences in position and numbers of bats (*M. lucifugus* and *M. "subulatus"* [= *keenii septentrionalis*]) from January to April, but explained the movements on the assumption of varying activity of the same bats under seasonal and temperature changes. Howell (1908) observed groups of bats migrating on a late September morning near Washington, D. C. Although identifications were not possible, Howell believed that individuals of *Myotis* and *Pipistrellus* were among those seen.

The caves visited during this investigation are inhabited by only one species of bat, *M. grisescens,* during the summer months, but three species, *M. sodalis, M. lucifugus,* and *Pipistrellus,* are conspicuous winter residents. Two other species, *Eptesicus fuscus* and *Myotis keenii,* have been collected in the winter. A summary of the occurrence of each species will show its seasonal movements for the particular period over which it was studied. In this connection, Tables 1 and 2, which give the daily deviations from normal temperature and the daily maxima and minima together with the dates on which collections were made, should be consulted. Although the temperature data are from the Columbia station, the caves are within a radius of 10 miles, and temperature differences over such a range in this region cannot be great. While it is impossible to determine the factors conditioning the movements of these animals, there are repeated indications in these notes that temperature is a very important one, especially unusual winter temperatures. It is not, however, supposed that the internal condition of the bat is without influence on its seasonal activities. It is hoped that the cytological investigation will yield information on this aspect of the problem. The present data will be summarized for each of the different species.

Myotis grisescens

M. grisescens returns to this region, or passes through, toward the end of April but does not become a cave resident, except temporarily, at that time. Mature females go into the Rocheport Cave at about the time they give birth to their young. In both 1931 and 1932, they were abundant on June 20 and had come in

within a fortnight. It is not known whether this return was conditioned by the end of gestation or by the temperature; the maximum temperature had exceeded 90°F. with a deviation of +8°, in both years. Whether there was a major influx or whether the numbers were gradually increased could not be determined. Only a few pregnant females have been collected, and in every case parturition occurred within a few hours. It should be possible to get some check on the factors concerned by the movements of immature females and males, but they were segregated for the most part as has been reported, also, by Howell (1921). Very few immature females were with the lactating ones. If males were in the Rocheport Cave during the summer, they must have been near the entrance of Sinking Creek ("Z") where one was killed. At Hunter's Cave, immature females and males constituted the main population and were present before the end of June. Conclusions as to whether all members of this species return to the caves at the same period cannot be drawn from the data obtained.

The first record of association of old males with old females at Rocheport was on September 22 when the females were greatly in the majority. Migration apparently occurred at somewhat different periods for the old and young, and segregation of sexes was still conspicuous. Records during October from both caves make this clear. From the end of October and throughout the winter, only a few individuals were present, sometimes in groups with *M. sodalis* and sometimes isolated near the entrances. The returning groups observed in the early spring again showed segregation as to age and sex. The age segregation is doubtless to be correlated with the observations on the retarded follicular growth in the young females of this species.

Myotis sodalis

M. sodalis is apparently not a true hibernator in this region, since the records give clear indication of conspicuous movements following breaks in winter temperatures. The species appeared in the Rocheport Cave early in October after a maximum of 61° and a minimum of 49°F. were recorded on September 26. Young of both sexes, with many more males than females, formed the scattered vanguard preceding the large group movements that were recorded toward the end of October and beginning of November. Although the sexes occurred in approximately equal numbers in the groups counted, young animals greatly outnumbered old ones in the collections. If one can judge by the torpidity of the bats in the caves, migration was over toward the end of November. In the first part of December, the numbers were not large, and the groups were quite inactive. However, as early as December 26, following a week when temperatures were from 16° to 23°F. above normal with a maximum of 63° and a minimum of 47° on December 23, a conspicuous increase in numbers was observed at Rocheport Cave. On January 16, after another considerable divergence of temperature with a minimum of 48° on January 12 and a maximum of 63° on January 13, very few were present. Small groups were apparently held by the temperatures preceding the collection of February 6, but after that very few specimens were observed.

The 1931–32 records to which reference has just been made can be compared with the 1931 notes, which show that many *M. sodalis* were present on March 5 and 9, absent on March 16 and 23 and found again on March 30. By comparing the temperature records it can be seen that in 1932 conditions may be considered

favorable for continuous movement throughout February. The deviations were distinctly greater than in 1931 when the maximum was above 60° on only three days. In 1932, temperatures above 60° were recorded for ten days and maxima above 70° were recorded on four days. The fluctuations in March, 1931, would tend temporarily to stop migrations, and at such intervals this species was present in the cave. The conspicuous difference in numbers of *M. sodalis* in the Rocheport Cave and in Hunter's Cave should be noted in connection with the location of the former near the Missouri River. It is quite possible that such a waterway may be of some significance in migration.

Myotis lucifugus

M. lucifugus is the only species of *Myotis* that is a conspicuous hibernator in the caves visited. Very few individuals were present during October; entrants began to be numerous toward the end of November and by mid-December were well established. It apparently takes temperatures varying from a maximum of 50° to a minimum of about 32°F. to drive these bats into the caves in considerable numbers. Both sexes occurred in approximately equal numbers, but old animals predominated. Specimens were quite torpid until mid-January when some activity was observed; numbers were increased on February 6 and conspicuously on February 20 after a maximum of 77° and a minimum of 63°F. had been recorded on February 10. At the latter date the entrance of young bats had made them equal the old ones in number. Indications of movement were noted on February 28 at Rocheport by the occurrence of *M. lucifugus* in a new location nearer the entrance; and on the same day at Hunter's a specimen was taken from the entrance passage. Young ones were now definitely more numerous. Throughout March this species was present, but early in April the numbers were noticeably reduced and the last ones were taken on April 16; most of them were old. Sherman (1929) reported that *M. lucifugus* left its places of hibernation during the latter part of April and returned about the middle of October; the records were from National, Iowa (latitude 42°57'N.).

The beginnings of activity and changes in numbers can be closely correlated with the temperature changes. The fact that *M. lucifugus* breeds in this region is indicated by the young specimen shot on June 25. It is, therefore, not surprising that they should accumulate in the caves until feeding conditions are favorable instead of continuing their movements at every open season as does *M. sodalis*.

Myotis keenii

The only specimens of *M. keenii* were taken on February 6 and are considered to have been temporarily held in Rocheport Cave during the movements in which *M. lucifugus* and *M. sodalis* also took part.

Pipistrellus subflavus

Pipistrellus is not present in such large numbers as *M. lucifugus* but is, apparently, a typical hibernating resident, more numerous at Hunter's than at the Rocheport Cave. Individuals entered the caves by the middle of October and became very torpid. The records show more males than females in many cases, but the significance of that is nullified by the fact that

females were usually kept for study while the males were sometimes activated and were left in the caves. Variations in numbers up to January are also not significant at the Rocheport Cave because all specimens were collected by that time. From the time of entrance until January 16, no activity had been observed in this species, but on the latter date new individuals had entered the Rocheport Cave. This is the date on which activity was first noted in *M. lucifugus* and it followed some very unseasonal temperatures. No other conspicuous increase in numbers was noted until February 28, when activity was observed at Hunter's Cave and specimens were collected in the entrance passages of both caves. Until the end of April, both sexes were present in equal numbers at Hunter's Cave; by the middle of May only males were found, and they were feeding. This situation continues throughout May. In June, *Pipistrellus* was not seen in Hunter's Cave, but one was shot near the entrance. One male was netted at the Rocheport Cave on July 1, 1931.

Eptesicus fuscus

Eptesicus is probably not to be considered a typical cave resident. Found only at the Rocheport Cave, it occurred near the entrance with few exceptions. It was always very inert, and frequently hung in well illuminated and unprotected places. The first collections, in October, were all males. Few females were taken in November, but they became more numerous during the first part of December. On January 16, it was evident that this species, too, had responded to temperature variations by moving about. All the females that were seen were collected on that date, and none were found later. A few males remained until spring, and one was taken on June 19, 1932.

SUMMARY

The six species of bats observed differ not only in their structural characteristics but in their habits of life. The data presented in this paper indicate that it is possible to make certain correlations between changing temperature and the seasonal movements of bats in and out of caves and from one region to another. However, so long as observations are made in isolated regions, one can expect to learn relatively little about these widely distributed mammals. Certainly this is a rich field for coöperative study, and it is to be hoped that such a project will eventually be undertaken.

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Department of Zoölogy, University of Missouri, Columbia, Missouri.

NOTES ON THE LIFE HISTORY AND BEHAVIOR OF NEOTOMA FUSCIPES

BY FAE DONAT

The purpose of the following paper is to record observations made during the past two years, both in the field and in the laboratory, on two races of the dusky-footed wood rat, *Neotoma fuscipes*. It is shown here, current opinion to the contrary, that *Neotoma* can be induced to breed in captivity if proper conditions are supplied. Other observations concern general behavior of the rats and their adaptations to new environment.

METHODS

Tin box traps, baited with a combination of rolled oats, peanut butter, and raisins, were used. A cheesecloth bag of this mixture was tied to the trigger, making it necessary for the rat to use enough pressure in removing the bait invariably to spring the trap. A small amount of dry rolled oats was sprinkled in the trap and near its opening to lure the rat inside. The traps were 9 x 9 x 14 inches, one end being closed by a square door of heavy wire netting, fastened to an ordinary snap rat trap so as to spring shut when the animal nibbled the bait ball. By this method over 50 specimens of *Neotoma fuscipes annectens* have been trapped in the environs of Berkeley, and 30 specimens of *Neotoma fuscipes macrotis* near San Diego.

The rats are kept in separate white enameled cages 13½ x 13½ x 24 inches, containing a fitted tray for shavings, and a nest box. They are fed daily a dry mixture of rolled barley and sunflower seed, and a wet mash of wheat germ, alfalfa meal, codliver oil, and milk. Three or four times per week they are given lettuce, clover, or other fresh greens. An inverted bottle of water with copper drinking tube is fastened to one side of the cage.

A convenient apparatus for handling the rats, especially *Neotoma fuscipes annectens*, which is larger and fiercer than the southern sub-species, consists of a wire mesh cylinder with a cap hinged on at one end, the other end being left open to admit the rat. When his head is introduced into the open end he scrambles into the cylinder and is held there by two sticks thrust through the meshes, one above and one below the base of the tail. By this method he can be handled with safety and can easily be set free again by opening the cap.

BREEDING

Neotoma fuscipes annectens is reported to breed only in the spring. Judging by appearances, the rats in Strawberry Canyon, part of the University of California campus, begin breeding in late March and early April. At this time the testes of the males are scrotal and, in any one animal the penis seems to be larger than in late summer, fall and winter. Females trapped at this time often give birth to young after capture. Out of six cases the earliest record I have for the birth of young rats is April 6. The latest is approximately May 8. Three of the six litters contained three individuals, and three of them two individuals.

Rats trapped near San Diego in early May, as compared with those caught near Berkeley at that time, indicate that the breeding season for *N. f. macrotis* occurs earlier in the year than for *N. f. annectens*. At that time young rats, nearly full grown, were captured. Gander (1929) records having caught a pregnant female in that region as early as December 12.

Examination of vaginal smears for oestrous changes in *Neotoma fuscipes annectens* have, with one exception, shown only leucocytes and epithelial cells, characteristic of the dioestrous interval, stage V of Long and Evans (1922). The exception occurred in a rat that was examined after having been in the same cage with a male for three days. This female showed the many cornified cells of stage III, which follows the period of heat as described in the albino *Rattus*. Three days before being placed with the male she had given birth to three young which she killed and partly devoured. The facts that no sperms were seen and that pregnancy did not occur may indicate that the male rat was not sufficiently developed. Examinations of two females on six successive days, from May 16 to 21, as well as random examinations of all females caught during March and April, have shown only the dioestrous stage.

The above facts indicate that the female wood rat does not undergo the regular four-day oestrous cycle observed in albino *Rattus* (a member of a different family, it must not be forgotten), and that perhaps where stimulus from the male is lacking, or in a strange environment, no cycle will occur, even in the breeding season. It is possible that only a very few cycles take place in a normal female during the breeding season.

That male rats kept in captivity for some time develop sexually later in the season than adult males in their normal habitat is shown by the case of *N. f. annectens* No. 15, a rat which has been in the laboratory since July 12, 1930, a period of nearly two years. Although full grown when caught and always in splendid physical condition, this specimen showed no evidence of sexual activity until May 27, 1932. The development of the external genitalia at this time corresponded to that of rats trapped in late March or April.

The young borne by females trapped during pregnancy have not, as a rule,

survived more than a few days. In the new environment the mothers seem too frightened and nervous to care for their young. Two rats in which the vaginal smears showed spermatozoa on the morning after capture, and also several which were judged to be pregnant on the basis of enlarged mammae, failed to give birth to young. Autopsy of one case showed three implantation sites in the uterus where embryos had either been resorbed or aborted. Abortion has not been observed in any of these cases.

Newborn young of the cricetine *Neotoma fuscipes annectens* are larger than newborn young of the Wistar Institute strain of the murine albino *Rattus norvegicus*, which happened to be available for comparison. Average weights and measurements taken by me of five newborn young, from two litters of *N. f. annectens* and six newborn young of one litter of *R. norvegicus*, are respectively as follows: weight, 10 grams, 4.7 grams; body length, 56 mm., 48.6 mm.; tail length, 23 mm., 15.2 mm. The dorsal body parts of newborn *Neotoma* are dark grayish, and the ventral parts dull red. There is a slight amount of body hair at birth, and the oral vibrissae are quite conspicuous. The dorsal pelage, at two weeks, is dark gray, short and very soft, the underparts and feet being white. At the end of twelve days the eyes of one litter were still closed, but were observed to be open on the twentieth day.

The female has four inguinal teats, to which the young remain attached during most of the first three weeks. She scampers and climbs about with the young protruding between her hind legs, and though I have seen a mother squeeze through small cracks and run over piles of sticks so as to jolt the young violently, they have never become dislodged. That there are times when the young either let go voluntarily or are disengaged by the mother is shown by the fact that she frequently comes out at dusk without them. I attempted to remove two young ones from their mother at the age of 23 days, but they held on so tightly that, for fear of tearing the flesh of the mother, I let them remain. These two young were weaned and placed in a separate cage from the mother at 36 days, and now at the age of 60 days they are in fine condition.

Neotoma has been reported not to breed in captivity, but after several unsuccessful attempts with *N. f. annectens* in cages of varying sizes had been made, a method was adopted that has proved successful. A room 10 x 17 x 9 feet with two north and two west windows was cleared of all furnishings except a radiator located between the north windows. Sticks and leaves from an abandoned wood rat nest were deposited in the middle of the room. Two rats were turned loose in this room on March 28, 1932. The male was a large, sexually mature specimen trapped on March 4, 1932. The female had been in captivity since August 8, 1931. Although full grown at the time of this experiment, she seemed never to have borne young, as indicated by: (1) a vagina completely closed by a membrane, and (2) small nipples covered by relatively smooth skin, rather than the larger nipples with wrinkled skin characteristic of females known to have suckled young.[1]

[1] Three adult females of *N. f. annectens* were examined on August 11th, when the vagina of each was found to be open. One of these had borne young on May 8, and another on April 7. The third had not borne young in captivity, but the vaginal tract contained spermatozoa at the time of capture on March 23. No

Some shavings and fine sticks were placed in the northwest and northeast corners of the room to encourage the building of nests there. On the third day, however, it became obvious that the rats had ideas of their own as to the most suitable place for a nest, namely, the radiator. Under it and between the pipes were a few sticks, apparently placed there by the rats. On succeeding days this radiator nest grew in size until at present it consists of an elaborate collection of branches and twigs of all sizes interwoven through the radiator, piled on top of, and around it. The rats in Strawberry Canyon usually build their nests in bushes or low trees, so the analogy of the radiator structure to these is most interesting.

On April 5, a second female with additional nest material was introduced into the room. Two days later she was found dead, with deep lacerations on her flanks and back. Apparently the original pair did not welcome the intrusion. Whether the male or female killed the newcomer I was not able to determine.

On April 11 I placed some scraps of bright colored paper and silk and a few pieces of bright tin on the floor. The next morning the silk and most of the tin had disappeared. The paper seemed less attractive, since only one piece had been removed, and that could be seen sticking out of one side of the nest. A large piece of cotton batting placed in the room at a later date was likewise quickly stowed away.

To see a rat drag a heavy branch over four feet long and an inch thick across the room was quite surprising, but many such were used in constructing the nest. I never saw the female do any of the building, only the male, but since my observations were limited to the time between dusk and dark, when the rats began their activities, perhaps the female did assist at times. The rat I observed seemed to be quite particular as to the stick chosen, as he would run about sniffing first one, then another, before making a choice. Bracken fern seemed to be a highly favored type of nest material.

Upon first emerging from the nest, after my appearance at the door, the rat usually would sit at the west entrance of the nest, eye me alertly and sniff the breeze. After a few minutes of this it would make several short advances toward my position at the south entrance to the room, beating a hasty, frightened retreat into the nest after each advance. Finally, one night it came all the way over to the door and sniffed the screen behind which I was standing. I made no move to disturb it, and after that it seemed less afraid. All movements by the rats were made in short advances, with frequent cautious stops near some concealing bit of brush or branch, to look and listen for danger. Noises outside the windows made

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males had access to these females after the dates given of bearing young or capture. On August 11 no indication of reformation of the membrane was macroscopically visible. Similarly, two adults, of unknown history, of *N. f. macrotis*, examined at the same time, had the vaginae open after three months in isolated cages. However, an immature female of the same race, kept under like conditions for approximately two months, did have the vaginal membrane present.

Miller (1895, p. 460), states that in two species of *Microtus*, two of *Evotomys* (= *Clethrionomys*) two of *Peromyscus* and one of *Mus* (= *Apodemus*) the vaginal orifice is closed again by a membrane after both copulation and parturition. That this is not always, if ever, the case with *Neotoma fuscipes* is indicated by the above examinations.

by other animals seemed at first to be disturbing, but later even the most frightful din made by dogs barking and ducks quacking appeared to be accepted quite as a matter of course.

In running about, the rats ordinarily carry the tail approximately parallel to and about one inch from the ground (Dixon, 1919, p. 59). In cases where the male is pursuing the female, her tail may be carried higher, the posterior half curved upward, the whole tail occasionally twitching. I have never actually observed copulation.

Only at infrequent intervals did I see both rats at once. However, their behavior at first indicated that the male was the pursuer. Often the male was seen to emerge from the new radiator nest while the female stayed in the remains of the original pile of brush in the center of the room.

On April 28, twenty-one days after being placed in the room, there appeared to be a sudden change in the attitudes of the two rats toward each other. The female seemed very antagonistic toward the male. She established herself in the new nest and refused to tolerate his presence. During the day, when both rats would normally be in hiding, I noticed the male sitting humped up in the northwest corner of the room. On seeing me he dashed toward the radiator nest, but the female met him at the entrance with something in her attitude that made him meekly return to his corner. Since I continued to stand at the door and watch, he attempted twice more to enter the nest, but each time decided that I was less to be feared than his companion. Finally he curled up in a ball in his corner and ignored us both.

On this same day a table with a tall cage containing another pair of wood rats was placed in the room. On the following morning I discovered that the male that was free in the room had started to build himself a nest on top of this cage. At the time it consisted of only a dozen or fifteen small sticks. It was quite amusing to see the rat humped up in a round ball, his nose between his paws, trying to hide behind such a tiny pile of sticks. His constructing a nest on top of this high cage is of interest, since it is said that in nature the male rats leave the females after breeding and build nests in trees. Many of these tree nests can be seen on the south slopes of Strawberry Canyon.

The rats in the cage on the table were removed to other quarters and the door of the cage left open. The next morning the male rat was found inside this cage, so the door was closed and the female left alone in the room. Examination showed the male rat's tail to be badly lacerated; no other marks of fighting were evidenced.

On April 15 the radiator nest was partly dismantled to see if the female had given birth to young. At the east end of the radiator, near the valve, was her nest, composed of shredded cotton, the scraps of cloth I had placed in the room, bits of fern, small twigs and grass. It was a deep, roundish nest with a small entrance hole at the top. Surrounding its base was a large amount of wet mash, now dry and mouldy, and a smaller quantity of barley and dried grass. The female was not in the nest, but was seen behind the radiator with two young ones attached to her teats. They appeared to be three or four days old. The sticks of the nest were replaced as well as possible and the family left to their own devices until three weeks later, when they were placed in a cage, where they are now thriving. At time of removal from the room the female and two young (both males) weighed 230, 64 and 66 grams, respectively.

To sum up this experiment: The male and female were together 29 days; the female had been alone 16 days when the young were discovered; the male was seen pursuing the female, with subsequent antagonism of female for male, about 23 days before birth of the young. Therefore, the probable gestation period in *Neotoma fuscipes annectens* is 23 days.

It is possible that birth of one or more individuals of a given litter may be delayed, as described by Svihla (1932, p. 12) in *Peromyscus*. One case was noted in which a female *N. f. annectens* was observed to have two newborn young on April 7. On April 13 the cage was thoroughly cleaned while the two young remained attached to the mother as she ran about. On April 15 the female was observed to have three instead of two young. One of these appeared smaller than the others; its skin was more reddish and the fur shorter. On April 18 the three young weighed 31, 29 and 21 grams, respectively. The smaller one died shortly after being weighed. Supposing the third rat to have been born immediately after the cage was cleaned, it would be at least six days younger than the others. This is such a great age difference that the writer, before forming any conclusions, feels that further observations are necessary. It is possible that the third young rat, though unobserved, was attached to the mother's nipples, along with the others, at the time the cage was cleaned.

BEHAVIOR

An interesting reaction of these animals is their indecision as to what move to make next when suddenly set free or exposed to view when in hiding. *N. f. annectens* is difficult to remove from a cage, becuase of his swiftness and adroitness in dodging, but if he manages to dart out of the cage, he usually just sits on the floor and looks around rather than running for cover. This same attitude was manifested by *N. f. macrotis* in Verdugo Woodlands near Glendale, California, one rainy day in November when we lifted up a nest, exposing its occupant curled up in a pile of dry grass. He seemed too utterly astounded at such a proceeding to move, and permitted us to pick him up with scarcely a struggle. On another occasion when I liberated four females in Strawberry Canyon after keeping them in the laboratory during the breeding season, all of them were rather slow about going off into the brush. Two of them stopped to sniff at some small green plants growing in the stream bed, and another did a most surprising thing. She ran across the dry creek bed toward a corner in the opposite bank, deliberately waded through a small pool of water to a stone in its center, and, after some maneuvering, swam about one and one-half feet to dry land and ran up the bank. She seemed to feel no great aversion to getting wet, as she sat partly immersed in the water for some minutes.

When handled, these animals, especially the wilder individuals, utter a harsh, shrill, rapidly repeated squeak. Another characteristic sound is a soft snuffing noise accompanied by rapid quivering of the vibrissae when the rat stops to smell some strange or interesting object. The very young rats, when not nursing, often utter a wheezy, whimpering, almost insect-like sound. I have listened for sounds by the young in the laboratory radiator nest when the mother was out foraging, but the rats were over a week old and had apparently learned to keep quiet.

The adult rats of both sexes, when excited or nervous, produce a peculiar drumming sound by rapidly beating the tail against the ground or brush. I heard this

drumming by *N. f. macrotis* when setting traps one night in Murray Canyon, San Diego County. I have also heard the same sound produced by the male *N. f. annectens* while with a female in the breeding room. At first I considered this as sexual behavior, but on several later occasions I noticed the same drumming by the female after the male had been removed, so perhaps it is a nervous reaction to disturbances of various kinds, or it may be a warning sound to spread alarm to other rats. A similar drumming produced by beating the forepaw against any nearby object is described in *Peromyscus* by Seton (1920) and Svihla (1932).

Much has been written on the propensities of wood rats to store away great quantities of useless as well as useful articles in their nests (Taylor, 1920; Warren, 1920). In Strawberry Canyon the nests have disclosed such peculiar items as a small tin cup, bits of lace, nail file, handkerchief, silk thread, and shreds of newspaper. In one small nest over a peck of hazel nuts were discovered (Anthony, 1920).

Most of my opportunities to study the general behavior of *Neotoma fuscipes annectens* in captivity have come through rat No. 15. He has been in the laboratory for nearly two years and is in splendid physical condition. Though he was nearly full grown when captured, he has never been very wild.

He seems able to distinguish individuals, as he shows quite a friendly interest in the person who feeds him, even though no food is being offered at the time. He has a great fear of men in general, and of the manager of the animal room in particular, who usually catches him for me. At the sight of him he dashes into his nest box and stays there until removed by force. If I want him to go into his nest box, all that is necessary is to let him smell the gloves worn by the manager, or a bottle of lysol. Apparently, he has learned to associate these smells with being caught.

His nest box is fitted with a small sliding metal door that serves to shut him in while his food dishes are being filled. This has lost its original usefulness, because he has learned to open it with his teeth either from the inside or the outside.

He is very active during his waking hours, gnawing great holes in his nest box and shaking with his teeth loose portions of his cage. He carries his tin food cups around in his teeth and usually deposits them on top of his nest box. He likes to dig busily in the shavings, making little piles here and there. Within the last month (May) he has persistently piled all the shavings in one corner of his cage, making a nest in their midst where he sleeps, instead of in the box. I have at times tried to push him off the top of his nest box with a heavy wire in order to make him go inside, and it has become quite a game to him to sidestep or jump over the wire and stay on top of the box in spite of my efforts to dislodge him.

Even in a small cage he lives true to the reputation of his genus for storing things, especially food. When given grass or greens he fills his mouth as full as possible, stuffing the food in with his front paws, and carries several loads of this into his nest box for safe keeping before he stops to eat. Then he selects the choicer morsels, such as clover or miner's lettuce, and eats them a stalk at a time, sitting up on his haunches, holding the green with one or both forepaws. I have often seen him fill his mouth with barley or sunflower seed, hastily dig a hole in the shavings, thrust his nose into the hole, and emerge with his mouth empty. In eating wet mash, he takes a large mouthful, then with his front paws pushes

in the crumbs which adhere to the hairs about his mouth. After eating he washes his face meticulously, much as a cat does, except that he often uses the flat "palm" of his paw, rather than the side.

One night, after prolonged shaking of the cage front, he managed to push it out, unlatch the outer door and escape into the room. The next morning it was interesting to see that he had picked up small pieces of lumber, shingles and shavings, and piled them on top of his nest box in the cage in an effort to construct the kind of nest so typical of his species. Close examination of the lumber showed numerous tooth marks which he had made in dragging the pieces to their destination.

SUMMARY

1. Methods of trapping, handling and caring for *Neotoma fuscipes* in captivity are described.

2. That *Neotoma fuscipes annectens* will breed in captivity if suitable conditions are supplied is proved by a breeding experiment in which a litter of two was produced.

3. General behavior of *N. f. annectens* and *N. f. macrotis* in the field and in the laboratory is discussed.

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Department of Zoölogy, University of California, Berkeley, California.

NOTES ON THE RELATIONS OF BEAVERS TO ONE ANOTHER AND TO THE MUSKRAT

By Alexander H. Leighton

The following notes were made in the summer of 1931 at a small lake in the Bear River region of Digby County, Nova Scotia. I studied the beavers both in a wild state and in captivity in two pens built on the lake shore. The individuals to which reference is made in this article are: Paddy, a kitten, probably born the preceding May or June, sex unknown; Tony, a yearling, sex unknown; and Boadecia, an adult female. For a more detailed description of the conditions under which these records were made, reference is given to the introductory paragraphs of "Notes on the beaver's individuality and mental characteristics" in the Journal of Mammalogy, vol. 13, no. 2, pp. 117–126.

My observations of the captive beavers were made when sitting, quite visible to the animals, either in one of the pens or on a seat which was about five feet off the ground and slung between the two enclosures. After dark I generally used a flashlight, but it did not seem to annoy the beavers. There can be no doubt, however, that they were subject to conditions that were far from natural, and their behavior was probably correspondingly modified. In attempting to reconstruct a picture of the beaver's customary behavior, it is likely that negative characteristics, such as all forms of indifference, are the most misleading. However, I believe that the animal's response, even to a relatively strange environment, is something essentially peculiar to the animal and is at least a starting point for the study of behavior.

In organizing my notes I find myself unable to prevent a certain amount of over-lapping. This is due in part at least to the fact that although an observer, in order to comprehend and interpret a mass of material, must arrange it in categorical sections, such schemes are arbitrary and really not part of the living world. Therefore I should like to refer the reader to what has already been said in the first article on tail slapping, under fear; on mutual fur nipping, under habit; and the whole of imitation.

VOICE

Although some writers on the subject have said that the beaver is almost voiceless,[1] I was able to distinguish seven different kinds of cries, beside many unclassified squeaks and mutters.

[1] See Johnson, "Beaver in the Adirondacks," 1927.

Hiss.—This sound, to which I have frequently referred in my previous article, was made apparently in the nose by contracting the nostrils and breathing deeply and heavily. It was produced both on inhalation and exhalation, and I heard it more often than any of their other noises. Before I caught the beavers, I noticed it frequently in the bushes along the still water, sometimes when walking there in the daytime and sometimes when canoeing on the water itself at night. Later, when I had the beavers under close observation in the pens, I discovered that the hiss was used on a variety of occasions, but always correlated with displeasure on the part of the animals. They made it if angered and frightened by handling them. However there were certain times after Tony and Paddy became tame when they hissed in what seemed pure vexation, unmingled with any fear. This occurred if I blocked up the sod house in the morning to prevent their getting inside, or pushed them away from food that was on the bank. Many times Tony hissed at Paddy when the latter tried to pull away some of his food, or when out in the water he attempted to get on Tony's back. Once I heard Paddy hiss while swimming away after Tony had made a move to bite him. Both hissed repeatedly at a muskrat.

Whine.—By this word I mean to express a thin, scarcely audible sound that Paddy made sometimes when swimming about Tony or when penned in a small cage near the tents. It was of a ventriloquial character that gave me some difficulty at first in determining its source. Occasionally it led to the common cry described below. I never heard Tony or Boadecia whine.

Cry.—This is the sound which I believe is meant by many observers when they say that the voice of young beaver is like that of a wailing child.[2] The simile is as fitting as any I can think of, and yet it does not really convey a good impression of the call. The resemblance is only to the shorter cries of an infant. The beaver's voice rises and falls and carries a tone of mingled impatience and pleading that is indefinable, but none the less clearly marked. It has much in common with the usual pathetic notes of many young mammals. The general literature on the beaver gives one the impression that the cry is peculiar to young beaver and given chiefly when they are alarmed. Such was not my experience. It is true enough that Paddy cried most and that I never heard Boadecia do it, but Tony made the sound a few times, and the night I watched the beavers at the Halifax exhibition, two adults made quite a bit of noise in this way. Once when Paddy was being held down on a table preparatory to having his ear marked he made a little sound that might have been the cry, and he did the same thing on several occasions when he seemed fearful of Tony. However, aside from this I never heard a beaver, old or young, cry when frightened. On the contrary, I was struck by the fact that whenever they were making the cry and anything occurred to disturb them, they became instantly silent and then, perhaps, hissed. This was as true of them when they were at liberty in the bushes along the still water as it was afterward when they were in my pens. I had Paddy in captivity for two days before I heard him cry, and that occurred when I put him into the pen with Tony for the first time. It was over six weeks before I heard Tony make the sound.

Paddy cried under the following circumstances: frequently when swimming

[2] See "The Beaver," by Warren, and "The American Beaver and his works," by Morgan.

about Tony, when Tony approached him (this not always in alarm, for he often went forward to meet Tony), when summoned by Boadecia, once when Tony stepped on his tail, and when eating (especially when afraid that Tony would take some of his food, and very loudly if Tony did take any). Many times he did it for no reason that I could see. Tony sometimes cried when eating, especially if Paddy tried to push him away from the food, when they were mutually nipping fur, and when summoned by Boadecia. The beaver at Halifax cried while squabbling over food. From the above it is evident that the cry seems to be uttered both when the beaver is pleased and displeased. It is probable that the sound I have termed a cry is in reality a number of different calls which I was unable to distinguish. Like the whine, but to a lesser extent, the cry seemed to have ventriloquial properties. It was quite easy in the pens to tell which beaver was making it, but when they were in the bushes along the still water I had great difficulty several times in fixing their location.

Nasal sound.—This seemed to be peculiar to Tony and I did not observe it in him until he had been a prisoner for more than a month and a half and had become fairly tame. It seemed to be made while the breath was being drawn in through the nose with a slight suggestion of vocal cord vibration. I have heard dogs when pleased make a sound not unlike it. With Tony it also seemed indicative of good feeling and perhaps joyful anticipation, for I noticed that he only did it when coming ashore for his food. However, he did not by any means make the nasal sound every time he landed for this purpose.

Summons.—Tony and Paddy were kept in one pen and Boadecia in another that was separated from the first by two thicknesses of wire with a few inches between. Many times I saw Boadecia go as close as possible to the other pen, draw in her breath vocally (not unlike Tony's nasal sound) and then make a plaintive, rather high pitched straining call. It was very different from any other beaver noise, and she repeated it for a minute or more at a time. The effect on Tony and Paddy was instantaneous. No matter whether they were in the sod house, on the bank, or in the water, they both came running to the part of the wire nearest her and sometimes worked at it. Paddy cried and occasionally Tony also, but more often he responded with the same call. At times Boadecia gave the summons while out in the water, and swam by the wire. The other two then swam along with her. Once I heard Tony give the summons first; Boadecia answered and all three beaver came together by the wire.

Soft churr.—I heard Paddy make this sort of sound to Boadecia and once when placed for a few hours in a pen with another kitten which I have good reason to believe was his brother.

Guttural sound.—This was of a nondescript spluttering sort. I noticed it in Tony when I first picked him up the second day after his original capture.

BEAVER MEETING EACH OTHER

On July 25 Tony escaped, on the 27th I caught Paddy, and on July 29 I caught Tony again. When I put Tony into the pen he went out into the water and began attacking the wire at the lake end. Paddy was inside the house, so I removed a few sods from the roof and drove him out. Tony was submerged when Paddy entered the water, but as soon as he reappeared, Paddy swam over to him full of interest. Tony, however, paid not the slightest observable attention to him.

Paddy swam about, keeping his face close to that of Tony. He climbed up Tony's back several times and once rode across the pen in that position. Frequently he gave the cry. At length Tony noticed him sufficiently to hiss loudly a number of times. This seemed to have the effect of driving Paddy away for a few moments, but he soon returned and continued to follow Tony. At intervals Tony dived and sometimes in doing so he pushed Paddy under. Sometimes Paddy was sitting on his back and went down with him.

One could not want a greater contrast in the behavior of the two; Paddy friendly, noisy, and seeking attention; Tony stolid, silent, and hostile or indifferent. It might be thought that the explanation lay in the fact that Tony, having just been recaught, was more frightened than Paddy. It is possible that this is true, and yet Paddy had been in captivity only two days, while I had had Tony from July 8 to 25 and had caught him again because he came back to the pens at night looking for the easily accessible food. Moreover, as time progressed, it became evident that Tony was the tamer of the two.

On August 22 the second kitten was caught and unfortunately broke its leg in the trap. I was not in the camp at the time, but Mr. Harris put him in the pen next that of Tony and Paddy and recorded their behavior.

"Both Tony and Paddy were out in the water. Paddy noticed him [the second kitten] right away and went over to the wire and put his nose through and cried. The new beaver did not pay any attention to Paddy for some time; then he went over to the wire and swam up and down along it. After some time Tony came over and sniffed through the wire."

I arrived in the camp about noon and put Paddy with the second kitten. Paddy swam to him making the soft churr, put his nose close to his, and then swam about him. The second kitten showed interest in Paddy and thereafter did not dive as often as he had been doing. Several times Paddy put his forepaws on the other's neck and shoulders and once attempted to climb on his back.

On the morning of August 26 when Mr. Harris caught Boadecia, who was probably Paddy's mother and perhaps Tony's, he put her in the pen next Tony and Paddy and noted that the other beavers registered interest in her, but retired into their house at 7:30 a.m. In the later afternoon I disturbed Tony and Paddy so that they came out and idled about the bank and in the water for half an hour or more. They paid no attention to Boadecia, who was out in the water in her pen, nor did she show any sign of being aware of their presence. At 6:30 p.m. the young beaver came out again, but I did not remain on watch. When I visited the pens at 11 p.m. Boadecia had eaten plenty of waterlilies, but the state of indifference between her and the younger beaver seemed still to persist. I watched the beavers from 6 to 10 p.m. on August 28 and again from 8:30 to 10 p.m. on August 29. Paddy spent a little time looking through the wire at the other pen, but there were no friendly overtures. Tony and Paddy spent the early part of the latter night inside the house. On August 30 I watched the beavers from 8 to 11 p.m. Paddy was more than usually interested in working on the wire, and almost always on the side next the other pen. He attacked the fencing on the land, a thing which I never saw him do before or afterward. Once he swam along the wire on the side next the other pen, looking through and churring. Boadecia came over, but made no sound and soon swam away again. I watched her closely while Paddy was making a fuss over his food and crying, but I could not see that she

reacted in any way. Tony swam along the side nearest her several times, but I could not be sure that he was looking at her. It was quite customary for him to swim there long before she was caught. From September 2 to 5 I was in Halifax at the exhibition, but aside from that time the beavers were watched more or less closely and continually without any change in their general attitude of mutual indifference being observed until September 9. I wished to get some moving pictures of the beaver's method of gnawing a tree and therefore on September 7 I tied a young poplar upright in Boadecia's pen and discontinued all her other food. On September 9 the beavers were watched between 12 and 2 a.m. Boadecia had had nothing to eat since September 7, but had not cut the poplar. She had not suffered from complete lack of food, for there were a few old roots and twigs in the pen upon which she gnawed. She was very restless and wandered back and forth and in and out of the water. It was now that I heard the summons for the first time and saw its remarkable effect on the younger animals. She made it eight times in all while I watched. In the mornings and nights that followed, I heard it frequently.

There may be some correlation between the summons and lack of food. The unsuccessful effort to make her cut a tree was continued with a few interruptions until shortly before she was sent to Halifax, so I did not hear her give the summons when completely free from the distress of hunger.

It is very likely that Boadecia was too frightened during the first day or two of her captivity to notice the other beaver, at least when I was about, and it is also possible that had I been able to keep a steady watch I might have heard the summons sooner. However I wish to point out and emphasize that this is another example of the deceptiveness of the beaver's habitual attitude of indifference. After I had had Boadecia for thirteen days I thought that she was almost entirely oblivious of the other beavers and they nearly equally unconscious of her. On the fourteenth day my opinion suffered a considerable change.

In July a wild beaver, probably Boadecia, was seen near the pens several times. Her visits were almost nightly from August 1 until her capture on August 26. I was unable to determine whether she came because of the poplar piled on the shore some fifty yards from the pens, or because of the other beavers. She was almost always seen and heard at the poplar pile but on the other hand, the beginning of her nightly visits was very nearly coincident with the capture of Paddy.

THE YEARLING'S TOLERANCE OF THE KITTEN

From August 4 until October 6, when I took them to Waverley, Tony and Paddy were kept together in one pen. Tony's attitude toward the younger animal was one of forbearance. This was surprising in view of his original hostile indifference. It may be that the tolerance was another facet of the same indifference. From the next section, in which I shall describe rows between the beavers, it may seem that Tony had very little patience, but it must be kept in mind how greatly and continually he was provoked. During the early part of the first night that they were together (July 29) Paddy seemed a little timid of Tony. Once he was sitting on the bank when Tony came toward the shore. Paddy cried and jumped into the water. I had placed rolled oats in a dish and Tony ate some. Paddy remained at a distance until Tony moved away toward poplar branches, and then he went to the dish and began eating. Soon Tony came back and took more oats. The little

one cried, but Tony made no sound and they ate together. Tony did not seem to mind the kitten's presence and in fact yielded to him when Paddy pushed in his direction. As the days went by the kitten became bothersome and impertinent. When they were eating oats he would often cry and attempt to push Tony out of the dish. Although there was plenty of poplar in the pen he seemed obsessed with the idea that the particular leaf or twig that Tony had was much better than anything else. When they were in the house he would walk over Tony, and out in the water he was continually getting on the yearling's back. Frequently when Tony was working at the wire Paddy would scramble over him and try to bite the same spot. Tony of course did not suffer all this without showing resentment, particularly if it was a question of food, but on the whole it took a good deal to provoke him, and he never really hurt the kitten.

QUARRELS BETWEEN THE YEARLING AND THE KITTEN

In the evening of August 5 Paddy was eating rolled oats when Tony came along and attempted to take some too. The younger one was standing partly in the dish and he cried and attempted to crowd Tony out. The yearling put his right forepaw on Paddy and with a backward thrust jerked him into the water. Paddy sat there a few moments chewing the mouthful he had and then returned to the oats and ate in a more civil manner. Ill feeling did not seem to persist long for shortly afterward Paddy rode across the pen (in the water) on Tony's back. On the succeeding days I saw Paddy chastised in this way numbers of times.

On going down to watch the beavers at 4 a.m. on August 14, I noticed that Paddy seemed afraid of Tony. Every time Tony swam in his direction he dived with a splash. Occasionally while Tony was working at the wire Paddy swam up and began gnawing beside him. Once or twice Tony turned about, placed his left forepaw on Paddy's nose and gave him a strong push backward. There were other times when the yearling merely hissed and Paddy swam away. I sat in the pen and held a poplar branch across my knees. Tony came ashore, reached up and pulled off a bunch of leaves and began to eat them. Paddy came over and attempted to take some from him. Tony hissed and turning, bit at his side. I do not think that Paddy was actually nipped, but he leaped into the water and dived. Shortly after this I gave Paddy a piece of poplar and Tony came after it. Paddy cried and dragged his twig to a corner and Tony turned quickly away. A little later Paddy had another twig, but was eating one of the leaves that he had detached. Tony came along and pulled the twig out from under the kitten. Paddy cried and went after it. Tony again bit at him and Paddy fled. Tony stole a second twig, but this time Paddy did not pursue it.

The fact that the beavers had not been fed the previous evening may account to some extent for Tony's bad temper and avarice at this particular time. It may also have been due to nervous excitement caused by a muskrat I had put into the pen on the 11th. On the evening of August 17 I again saw Tony stealing twigs from Paddy, but the kitten was more insistent on this occasion and ran after Tony crying, hissing, and snatching off leaves. It seemed an example of rudimentary property feeling, for he was never so pressing in his endeavors to steal from Tony as he was to recover the twigs Tony had taken from him. Although Tony would occasionally pull twigs away from Paddy, I never saw him attempt to take a leaf that Paddy was actually eating, even though he might not have been fed for some

time and the leaf was the only food available. Once I saw Tony chase Paddy away when the poplar branch he was eating was quite large enough for both of them. However, except for this one occasion, I did not see him resent Paddy when food was plentiful, as long as the kitten confined his attention to some portion of it that Tony was not eating.

The behavior of the beaver at the Halifax exhibition indicated that the scuffles between Paddy and Tony were probably customary. I watched two adult beavers eating and crying and noted that one made more noise and raised his voice when the other came near. The only kitten that was present attempted to take a few leaves off a branch the adult was eating and got cuffed. The kitten went away but soon came back and managed to take the leaves.

PLAY

On September 9, about 2 a.m., shortly after Boadecia had given a summons, I heard crying on the bank in the pen of Tony and Paddy. I turned the light in that direction and saw the yearling and the kitten facing each other. Both had their forepaws on the other's shoulders and neck, and they were pushing one against the other with their chests. They stopped after a few seconds and Tony went out into the water followed by Paddy. This was the only occasion on which I saw my beavers play. Perhaps the lack of this sort of activity was caused by the age difference between Tony and Paddy.

MUSKRAT AND BEAVER

Symbiosis.—At 11 a.m. on July 4, I went down the still water and thrust the canoe between the bushes up a small stream to the beaver house that I considered inhabited. I wanted to determine whether or not there were any little beaver in the house, and sat very quietly for an hour listening for their crying. A muskrat came swimming around a bend toward me carrying a piece of grass in his mouth. He approached almost to the bow of the canoe and then swerved to the right and disappeared under the house. Half an hour later the same thing occurred again.

I did not hear the little beaver in the house at this time nor at any other. Later, when I did locate them by their voices, they were always in the bushes along the still water. I have therefore no proof that the muskrats actually were in the house with the beavers. However, in the light of what follows I think it highly probable that they were living there together.

On August 11 I caught a male muskrat (hereafter to be called Jerry) and put him in the pen with Tony and Paddy where he remained until September 27. He took up his living quarters right away in the sod house along with the beavers. On August 14 I discovered that he had dug a little hole for himself at the back of the beaver chamber and from that time onward made it his bed. While watching the beavers about 1 a.m. on September 9, I was surprised to notice a muskrat wriggling out of the pen through the wire mesh. When daylight came I took the sods off the house and looked inside to see if Jerry had escaped. I was astounded to find that the muskrat nest at the back of the beaver chamber had been enlarged and contained five muskrats. Of these one was apparently Jerry, and the others were smaller animals that could go in and out through the wire as they pleased. Lest it be thought that I had captured a pregnant female, I reiterate the statement that beyond all doubt Jerry was a male. He developed such an attachment

for the place of his captivity that a few hours after I liberated him on September 30 a muskrat, almost certainly he, was back at the pen trying to get inside and remained in the general vicinity several days.

In one of my corral traps on the still water which was baited only with poplar I caught three muskrats, one of which was Jerry. On each occasion a good many of the leaves and some of the bark from the fine twigs had been eaten. There were many other nights when bait was taken without a capture being made, and the tooth marks indicated that the visitors had been muskrats. Jerry appeared to like carrots, rolled oats, and grass best, but he ate quantities of poplar leaves and some bark.

It seems to me that all these observations point strongly to normal symbiosis. If the muskrats came of their own accord to live in my artificial beaver house because of the food and shelter available, why would they not do the same thing in a real beaver house? Of course it is true that beavers do not keep a decoy muskrat to attract tenants, but I believe the advantages sufficient without that. Also, if the muskrat likes poplar leaves, but is incapable of getting them for himself, is it not reasonable to suppose that he steals them when the beaver has cut down the tree?[2]

The Beavers' Attitude Toward the Muskrat.—When the muskrat was first put into the beaver pen, Tony swam over toward him. Jerry allowed him to come within a foot and then he dived. Both Tony and Paddy dived too. Paddy went toward the rat several times, but the result was always the same—first the rat dived and then the two beavers. Jerry came ashore and sat on the bank. Paddy came toward him, hissed, and went away again. After a little Jerry moved off and then the kitten returned, landed at the same place and began brushing himself. Jerry found the entrance to the sod house and went inside. The beavers, who usually retired before 7 a.m., remained out until after 3:30 p.m. The relationship seemed in general to be one of suspicion and dislike. About 7 p.m. I looked into the chamber and found the two beavers crouched together in one corner and the rat in another near the interior end of the entrance tunnel. On August 13 the atmosphere still seemed strained, but a little less so than it had been. Several times the rat swam up within a few inches of a beaver, paused, and then either dived or swam off. Likewise Tony and Paddy occasionally came almost to the rat and then went away. Once the rat was crouching in a corner at the water end of the pen, supporting himself on the wire. Tony was working at the strands and edging over that way. He arrived beside Jerry, stopped, looked at him, rattled the wire with his paws, and then crowded over on top of the rat. Jerry wrinkled up his lips as if preparing to bite, squeezed past, and swam away. A little later Paddy tried twice to climb up on Jerry's back when he was in the water. The rat submitted for a second or two, then snapped at the kitten without biting him, and departed. Tony came up on the bank to get some rolled oats, but found the rat there ahead of him and went away again. After a few seconds the rat left and Tony returned for the oats.

On August 16 both the rat and Tony ate oats from the same little heap. Tony attempted to crowd the rat away with his nose. Jerry made little cries and then

[2] Dugmore observed this in Newfoundland. See "The Romance of the Beaver," p. 99.

snapped at Tony. The beaver jumped back to the water's edge, but soon returned and endeavored to edge the rat away. Jerry put his head under Tony and they continued eating together.

Tony and Jerry were eating rolled oats out of the same dish on August 17 when Jerry caught the dish in his teeth and tried to drag it up the tunnel into the house. He got it partly away from Tony by a sudden jerk, but the beaver pounced after it and drew it back with his forepaws, placed them in it, pressed his weight on it, and in this manner held the dish still.

On August 18 I saw the rat swim toward Tony and run his chin up on the beaver's back. Tony hissed and swam away and the rat also went quickly off.

This attitude of passive dislike was maintained by the beavers toward the rat as long as I observed them together. I never saw either beaver attempt to bite Jerry or strike him with a forepaw.

SUMMARY

1. Seven different kinds of beaver sounds were described: hiss, whine, cry, nasal sound, summons, churr, and guttural sound.

2. The kitten showed an immediate interest in other beaver, but the adult and the yearling appeared at first very indifferent. After the adult had been in captivity for two weeks, it was discovered that she could give a summons to which the others responded at once.

3. The yearling was in general quite tolerant of the kitten, but sometimes cuffed him, snapped at him, and even stole his food. The kitten himself was inclined to be bold and greedy.

4. The yearling and the kitten were seen to play only once.

5. From observations made on wild muskrats and on one that was kept with the beaver, it was decided that the rats probably live in the beaver lodge and are commensal with the beaver to the extent of taking some of the larger animal's poplar leaves and bark.

6. The beavers seemed to dislike but endure the muskrat.

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Princeton University, Princeton, N. J.

FOOD HABITS OF TOWNSEND AND COAST MOLES

By A. W. Moore

[*Plate* 2]

Public opinion throughout the Pacific northwest has generally credited moles with the destruction of seeds, roots, and bulbs, and at times with the actual consumption of the same. The habit of certain mice in using mole runways provided a logical assumption that these small rodents were responsible for the actual eating of the underground vegetable matter.

A rapidly expending bulb-growing industry in the area necessitated some definite information pertaining to the food habits of the Townsend mole (*Scapanus townsendii townsendii*). The small coast mole (*Scapanus orarius orarius*) is more general in distribution but is not so prevalent in cultivated areas as is the Townsend mole.

Wight (1928) tabulated the results of the examination of 306 Townsend mole stomachs and showed that but eight contained vegetable matter in sufficient amounts to indicate that it had been ingested intentionally. Two of these stomachs contained what were evidently remains of wild bulbs. These stomachs were taken from moles that had been obtained in part in the vicinity of newly planted and growing gardens. The availability of cultivated bulbs was not mentioned.

Food preferences obtained from cage trials have their limitations. A caged animal may be starved into accepting a certain food or may be thrown "off its feed" to such an extent that certain foods normally taken are refused. Chemical and physiological changes in sprouting and growing plants may make them more attractive *in situ* than when offered as a dormant seed, bulb, or wilting root. Individual variations will exist, and the number of trials by individual animals is limited.

To obtain some food habit data an enclosure of a quarter acre was constructed in the fall of 1929 at Hillsboro, Oregon. Mice were removed and excluded from the area. Earthworms, the moles' natural food, were plentiful. Six hundred mixed Darwin tulips were planted. A male Townsend mole was placed in the enclosure on February 26, 1930. Eleven tulip bulbs were entirely consumed by March 30. Eleven more were partly eaten or mechanically injured by the mole's activities. On April 2, 1930, 300 feet of garden peas and a soft white wheat were drilled in. Twenty-seven days later, 31 feet of the drilled wheat rows were about two-thirds taken and 26 feet of the pea rows were entirely taken.

Some sweet corn was eaten, and a few Irish potatoes were partially taken later in the year by the same mole.

Examinations were made before there was time for decomposition to have made a check unreliable. Another mole was introduced on the same area on October 13, 1930. The tulip bed had been replanted the first part of September. This mole, while working among the tulips. injured but two and ate none. Five bulbous iris were eaten out of 469 planted.

Indications are that parsnips and carrots are often consumed by this mole. More of the root is taken than normally would be removed by the mole in merely extending a runway through the row. Tops of the smaller plants are at times partially pulled down. Damaged surfaces show no trace of rodent gnawing.

Wallace W. Smith (1927)[1] writes of captive Townsend moles as follows: "Earthworms are taken in preference to everything else, but often after they have had all they will eat of these they will go over to the pile of mixed grains, and sorting them over with the nose will pick out and eat sometimes as many as twenty-four kernels of wheat. Night after night they sort over the piles of grain and in the morning not a kernel of wheat is left. . . . As far as my observation goes no other grain is taken. When they have had no worms for over twelve hours, grain is taken in preference to many insects. . . . Parlsey roots, tulip bulbs and parsnip roots were taken in small quantities, as a few nibbles. Carrots when very small and tender seemed to be enjoyed for a change but did not seem to be taken regularly, as was the wheat, though at times a mole would eat half or even a whole carrot three-eights of an inch in diameter by one and one-half to two inches long and at such times they seemed to be relished."

Two Townsend moles trapped from a commercial planting of tigridia bulbs near Smith River, California, contained 100 percent and 94 percent bulb in their stomachs. The first stomach was crammed, the other full. The soil was moist and earthworms were plentiful. About 600 bulbs had been consumed during a period of about ten days. Removal of the two moles stopped all damage to that portion of the planting. The only other bulbous plants in the area were yellow callas which upon digging several weeks later showed no root damage.

At the other end of the planting several pocket gophers were working. Their damage was more extensive, probably because of their storing

[1] Smith, W. W. 1927. Habits and control of the Oregon mole in the Willamette valley. (Junior Biologist thesis for rodent control.)

habit. The accompanying photos show the difference in type of injury. The bundle of tops with clean-cut bases is the result of pocket gopher damage; those shredded and torn resulted from mole activity. Practically all of the tops of those taken by pocket gophers were pulled down about an inch or two. Very few of those attacked by the moles had the tops pulled down to any extent.

The handling of over a hundred captive moles in lethal dosage determinations showed that the snout is little or no hindrance to the mole's attack upon the larger roots and bulbs. The snout nose is quite mobile and may be voluntarily bent up or sideways to an angle of nearly ninety degrees to its natural position, thus allowing the animal to bare its teeth (pl. 2, fig. 3). Indications in tulip plantings are that the bulbs are often shredded with the front feet and worked into the mouth.

The following groupings show the contents of 42 Townsend and 8 coast mole stomachs. With the exception of five obtained during August in a dry pasture near Tillamook, Oregon, and one July specimen from a moist garden at Hillsboro, Oregon, all were obtained along the coast near the Oregon-California line in October, November, and December, and as near commercial bulb plantings as possible. Two of the Tillamook specimens were *S. orarius* and were obtained in a dry pasture practically devoid of earthworms. One stomach contained one hundred percent earthworms and the other 90 percent diptera and no earthworms. The three Townsend stomachs from Tillamook averaged 65 percent earthworms and about 30 percent vegetable fibres. Analysis of stomach contents were made by Charles C. Sperry, of the Division of Food Habits Research, Bureau of Biological Survey.

CONTENTS OF EIGHT STOMACHS OF COAST MOLE (*Scapanus orarius orarius*)

Earthworms: Found in 6 stomachs. Three contained 100%, one, 95%, and two, 82%. Composite average, 69.9%.

Diptera (Two-winged flies): Found in 5 stomachs. One contained 96%, one, 90%, one, 12%, one, 3% and one, a trace. Composite average, 25.1%.

Lepidoptera (Butterflies and moths): Found in 3 stomachs to the amounts of 8%, 3% and 2%. Composite average, 1.6%.

Centipedes (Many-legged worms): Found in 3 stomachs. Two contained 2% and 1 contained 1%. Composite average, 0.6%.

Coleoptera (Beetles): Found in 5 stomachs, to the amounts of 4%, 3%, and in three, traces. Composite average, 0.9%.

Orthoptera (Crickets, grasshoppers, etc.): Three percent was found in one stomach. Composite average, 0.3%.

Hymenoptera (Bees, ants, wasps, etc.): Found in three stomachs. Two contained 1% and the other a trace. Composite average, 0.2%.

Vegetable matter: Found in 2 stomachs. One contained a trace and the other 10% of what was apparently gladiolus bulb. Composite average, 1.2%.

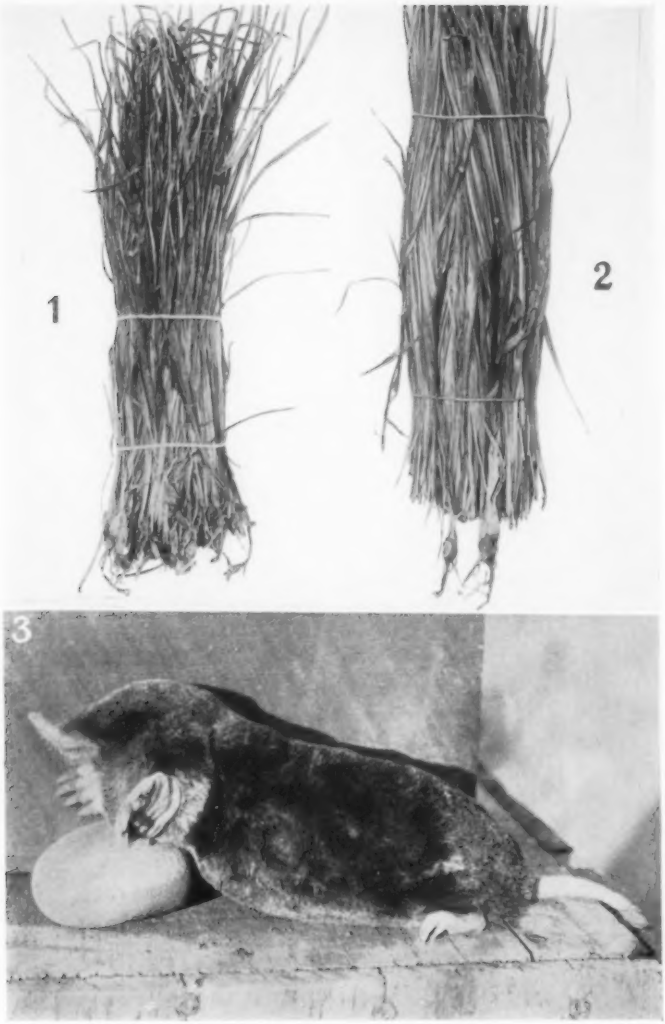

FIG. 1. Remains of Tigridia plants after Townsend moles had eaten the bulbs. Two undamaged bulbs may be seen to the left.

FIG. 2. Remains of Tigridia plants after bulbs had been removed by pocket gopher (*Thomomys laticeps*). Two undamaged bulbs also shown.

FIG. 3. *Scapanus t. townsendii*, showing angle to which mole bends nose.

UNIV. OF MICH.

CONTENTS OF 42 STOMACHS OF TOWNSEND MOLE (*Scapanus townsendii townsendii*)

Earthworms: Found in 41 stomachs. Ten contained 100%; 12, 90% or over; 9, 80% or over; 5, 50% or over; 2, 40% or over; 3, from 1 to 6%, and 1, not any. Composite average, 76.1%.

Diptera (Two-winged flies): Found in 23 stomachs. Twelve contained from 2 to 40% and ten contained a trace. Composite average, 5.6%.

Lepidoptera (Butterflies and moths): Found in 9 stomachs. Three contained 5%, 2 contained 1% and four contained a trace. Composite average, 0.93%.

Centipedes (Many-legged worms): Found in 23 stomachs. Six contained amounts varying from 5% to 2% and 17 contained a trace. Composite average, 0.5%.

Coleoptera (Beetles): Found in 17 stomachs. Four contained amounts varying from 5% to 2% and 13 contained a trace. Composite average, 0.3%.

Hymenoptera (Bees, wasps, ants, etc.): Found in 14 stomachs. One contained 2%, one contained 1% and 11 contained a trace. Composite average, 0.07%.

Orthoptera (Crickets, grasshoppers, etc.): Found in 3 stomachs, one containing 1% and two a trace. Composite average, 0.002%.

Arachnida (Spiders): A trace was found in one stomach.

Vegetable matter: Found in 24 stomachs. Nine stomachs contained bulbs to the respective amounts of 100%, 94%, 80%, 52%, 50%, 44%, about 2% and 2, traces. Vegetable fibres, roots, and grass were found in 7 stomachs to the amounts of 50%, 25%, 20%, 12%, 10%, 6%, and 2%. Bean fragments (vetch)[2] were found in 7 stomachs to the amounts of 16%, 10%, 2%, about 2%, 1%, 1% and 1 trace. Corn and oats were found in 3 stomachs to the amounts of 70%, 20%, and one, a trace. Composite average, 15.9%.

The number of stomachs in the coast mole group is too limited to permit definite conclusions. Nine of the 50 stomachs show definite indications of bulb and one other contained material that was evidently gladiolus bulb. It is definitely known that the five Tillamook specimens had no access to bulbs. Many of the others were taken before their tunnel systems were extended into the bulb plantings, and it is believed that a conservative estimate would be that not over 30 had actual access to any bulbs, including narcissuses and callas.

That oats and vetch had been planted for a green manure crop on the area where these moles were taken is clearly shown. Nine stomachs contained bean fragments (vetch) and two contained oats. The frequent complaint that moles have taken planted sweet peas may be readily explained when it is realized that peas and vetch belong to the same family and that the seeds are quite similar.

The presence of corn is more difficult to explain as the stomachs were taken in late fall and early winter, six months removed from the planting time. Some of the stomachs were obtained from a fence-row adjoining a field of mature sweet corn. A possible explanation is that mice had carried some of the corn within the runways, and that this corn was later found by the moles.

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[2] Vetch is a member of the pea family, genus *Vicia*. The dry seeds are about 4 mm. in diameter and usually brown in color.

SUMMARY

1. Tulip, tigridia, and bulbous iris bulbs, wheat, oats, peas, vetch, corn, carrots, parsnips, and potatoes often form substantial portions of the diet of *Scapanus townsendii* and *S. orarius*.

2. A vegetarian diet may at times be preferred to a fare of earthworms, insects, and other invertebrates.

3. Twenty-four out of 42 Townsend mole stomachs examined contained vegetable matter in sufficient amounts or in such form as to indicate that it had not been ingested accidentally nor been contained within the digestive tracts of ingested invertebrates.

4. For many cultivated plants the Townsend mole shows acquired tastes which are not influenced by a deficiency of supposed natural food.

LITERATURE CITED

WIGHT, H. M. 1928. Food habits of Townsend's mole. Journ. Mamm., vol. 9, p. 19.

Control Methods Research Laboratory, Bureau of Biological Survey, Hillsboro, Oregon.

A PRELIMINARY REPORT ON THE WINTER FOOD OF VIRGINIA FOXES

BY A. L. NELSON

This preliminary report on the winter food of Virginia foxes, based on the contents of 120 stomachs received from the Commission of Game and Inland Fisheries of Virginia and examined in the Food Habits Research laboratory of the Bureau of Biological Survey, is presented because of the great need for definite information on the food habits of these animals in a territory where there is a clash of opinion on the subject between fox hunters and quail shooters.

Of the 120 stomachs, 23 were empty; 82 of the stomachs containing food were gray fox, and fifteen were red fox. The gray-fox stomachs were taken by months as follows: 2 in December, 1931; 25 in January, 1932; 38 in February, 1932; 15 in March, 1932, and 2 not dated, but undoubtedly collected in January or February, 1932. Ten red-fox stomachs were collected in January, 1932, and five in February, 1932. Though the number of stomachs is small, the analysis will serve to indicate in some degree the winter food preferences of foxes in Virginia.

Urocyon cinereoargenteus cinereoargenteus
Gray Fox

Mammals as food.—Rabbit fragments were found in 34 of the gray-fox stomachs and comprised 32.41 per cent of the bulk content of the 82 examined. In 12 of

these stomachs, rabbit remains constituted 100 per cent of the food contents. A gray squirrel was noted in a single stomach and comprised less than 1 per cent of the entire food. Mice and native rats, found in 41 of the 82 stomachs, made up 18.20 per cent of the total bulk. The following genera were represented: *Microtus*, *Peromyscus*, *Mus*, and *Neotoma*. Three stomachs contained the wool of sheep, which formed a bulk percentage of 1.40.

Birds as food.—Small non-game birds were present in 16 of the 82 stomachs, making up a bulk percentage of 6.14. The following species were identified: Red-bellied woodpecker, robin, cedar waxwing, English sparrow, grackle, cowbird, cardinal, junco, white-throated sparrow, and song sparrow. Game birds were present in 3 stomachs, or in a bulk percentage of 1.33. Two stomachs contained mourning doves, and one, fragments of a ruffed grouse. Poultry fragments were found in 16 stomachs and made up a bulk percentage of 8.20. In 11 of these stomachs poultry was represented by feathers alone.

Reptiles as food.—In one stomach a young spotted turtle (*Clemmys guttata*) was noted, forming 8.00 per cent of the contents. In another stomach undetermined snake fragments constituted 5.00 per cent of the contents. The turtle and snake fragments together formed only 0.16 per cent of the total food.

Invertebrates as food.—The major portion of the invertebrate food was insects, which were present in 19 stomachs, forming a bulk percentage of 4.02. Three groups comprised 94 per cent of the insect diet: Lepidoptera, chiefly larvae; Orthoptera, represented by long-horned grasshoppers, short-horned grasshoppers, crickets; and Coleoptera, principally carabid and scarabaeid beetles. The only other invertebrates present were centipedes, which occurred in 3 stomachs and amounted to less than 1 per cent of the bulk.

Vegetable food.—Fruits, nuts, and grain were noted in 44 stomachs and represented 22.01 per cent of the total food. The most significant items were in the following order: Apples, beechnuts, corn, peanuts, grapes, and hickory nuts. The dry fruits (in a botanical sense)—beechnuts, corn, peanuts, and hickory nuts—comprised 10.90 per cent, while the fleshy fruits—apples, persimmons, and grapes—amounted to 11.11 per cent of the total food. Inasmuch as most of the foxes were taken in winter, it can be assumed that the cultivated fruits represented no economic loss.

Carrion was noted in 7 stomachs and comprised 5.40 per cent of the total food. Probably some of the poultry recorded should also be placed in this category. As far as the sheep occurrences are concerned there is little doubt that they represent carrion. Under normal conditions it is improbable that an adult fox weighing from 6 to 12 pounds would kill a sheep weighing from 75 to 300 pounds. Foxes may sometimes kill lambs, but they have been known to breed in the vicinity of sheep pastures without molesting either lambs or adults.

Vulpes fulva
Red Fox

Mammals as food.—Rabbits and mice together made up over half the food in the 15 red-fox stomachs examined. Rabbits, noted in 8 of these, formed 34.40 per cent of the bulk. Mice, noted in 6, amounted to 18.00 per cent of the diet, the genera

present being *Microtus* and *Peromyscus*. Muskrat fragments were found in 1 stomach and comprised 1.53 per cent of the bulk. Gray squirrel fragments were found in a single stomach and constituted 5.67 per cent of the total food. There is a strong probability that the squirrel was carrion as sarcophagid larvae were present with it in the stomach. Wool and fat of sheep, found in 3 stomachs, made up 13.07 per cent of the bulk.

Birds as food.—Quail remains were noted in a single stomach, making up 15 per cent of its contents, and comprising 1.00 per cent of the total food. Small non-game bird feathers, noted in 1 stomach, formed less than 1 per cent of the total food. Poultry fragments, found in 2 stomachs, made up 12.47 per cent of the entire food.

Invertebrates as food.—Insects, the only invertebrates noted, were found in 1 stomach and represented less than 1 per cent of the diet.

Vegetable food.—Fruits and nuts were present in 5 stomachs and represented 13.60 per cent of the entire food in the 15 stomachs. Beechnuts were found in 3 stomachs, making a bulk percentage of 9.60. Fleshy fruits—persimmons, and apples—were found in 2 stomachs, forming a bulk percentage of 4.00.

TABLE 1

Contents of 97 fox stomachs

FOOD ITEMS	GRAY FOXES (82)		RED FOXES (15)		ALL FOXES (97)	
	Number of occurrences	Percentage of total food in all stomachs	Number of occurrences	Percentage of total food in all stomachs	Number of occurrences	Percentage of total food in all stomachs
Rabbit	34	32.41	8	34.40	42	32.70
Mice and native rats	41	18.20	6	18.00	47	18.15
Gray squirrel	1	0.61	1	5.67	2	1.39
Muskrat			1	1.53	1	0.23
Sheep	3	1.40	3	13.07	6	3.20
Poultry	16	8.20	2	12.47	18	8.87
Game birds	3	1.33	1	1.00	4	1.27
Small non-game birds	16	6.14	1	0.20	17	5.21
Reptiles	2	0.16			2	0.13
Insects	19	4.02	1	0.06	20	3.40
Centipedes	3	0.12			3	0.10
Dry fruits	24	10.90	3	9.60	27	10.70
Fleshy fruits	27	11.11	2	4.00	29	10.10
Carrion	6	5.40			6	4.55

SUMMARY

In the winter months, at least, Virginia foxes feed largely on animal material, 79.20 per cent of the food reported in this paper falling into that category. Rabbits and mice are outstanding as staple winter foods; together they make up 50.85

per cent of the total. Apples, beechnuts, corn, persimmons, and peanuts are important vegetable foods, aggregating 18.82 per cent. The poultry and sheep items amount to 12.07 per cent of all the food; the former represented 8.87 per cent and the latter 3.20 per cent. Whether all of the occurrences of these two items, especially in the case of sheep, represent actual kills is questionable. This study indicates that small birds and insects are taken frequently, small birds represented by 5.21 per cent of the total food in all stomachs, and insects by 3.40 per cent, but that these items can not be considered important parts of the fox's winter food.

United States Biological Survey, Washington, D. C.

FOOD OF THE FUR SEAL OFF THE COAST OF BRITISH COLUMBIA

By W. A. Clemens and G. V. Wilby

There has been considerable speculation concerning the nature of the food of the fur seal, *Callorhinus alascanus*, during its northward migration each year along the west coast of Vancouver Island. It is the opinion of many persons that this seal is particularly destructive of salmon. As a preliminary step in obtaining definite information in this respect, the Department of Fisheries made arrangements in 1931 whereby twenty-five full stomachs were obtained from Indians sealing off Clayoquot Sound. The stomachs were preserved in formalin and later forwarded to the Pacific Biological Station where they were examined by the authors. This report is published with the permission of the Department of Fisheries, Ottawa, Canada.

There has apparently been no important published account of the food of the fur seal since 1899. In that year in "The Fur Seals and Fur Seal Islands of the North Pacific Ocean" (Part 3, Washington), by David Starr Jordan, there appeared a paper by Frederic A. Lucas entitled, "The Food of the Northern Fur Seals." In this paper it is recorded that the food of 36 fur seals taken in April in the Gulf of Alaska consisted almost entirely of squid (*Gonatus amoenus*). The food of 273 individuals taken in August and September in Behring Sea consisted largely of pollack (*Theragra chalcogramma*), seal fish (*Therobromus callorhini*) and squid (*Gonatus amoenus*). Other species represented in small numbers were rockfish (*Sebastodes alutus*), coho salmon (*Oncorhynchus kisutch*), lamprey (*Entosphenus tridentatus*), cod (*Gadus macrocephalus*),

wolf-fish (*Anarchias lepturus*), and stickleback (*Gasterosteus cataphractus*)

In view of the paucity of information, especially for areas south of Alaskan waters, and the general interest in the subject, the data in connection with the present investigation are given in some detail.

TABLE 1

Proportions (percentage of bulk) of principal food items in stomach contents of fur seals

NUMBER	SEX	AGE	HERRING	SALMON	SQUID	PILCHARDS	CRUSTACEANS	MISCELLANEOUS
		years						
75	♀	5	75	25			x	
76	♀		95	5				
77	♀	5–6	95		x		x	
78	♀		100					
79	♂	2–3		100				
80	♂	3		x	25			Hake
81	♂	2	100					
82	♀	3–4		100				
83	♀	4	80		20			
84	♀	5	85		15			
85	♀	5–6	85		15			
86	♀	5–6	75			25		
87	♀	2–3	95		x			
88	♂	3–4	25	65	10			
89	♂	4	100					
90	♀	3	10	90				
91	♀	4–5	100					
92	♂	2	100					
93	♀	5–6				100		
94	♀	5–6		x		95		
95	♀	5–6				80		One cottoid fish
96	♂	4–5				100		
97	♀	4–5				100		
98	♂		35	15	50			
99	♀	3	95				x	One osmerid fish

"x" indicates presence in undetermined amount.

Only well-filled stomachs were accepted by the fishery officer and the average amount of food in each was about one quart of well-packed material. For the most part the contents were much comminuted, making it usually impossible to determine the exact number of fish or

squids present in any one stomach, but in as many cases as possible the food items are expressed in percentages of total food content of stomach.

In the following lists and tabulations, the herring is the Pacific herring, *Clupea pallasii*, the pilchard is *Sardinops caerulea*, and the hake, *Merluccius productus*. The identification of the species of Pacific salmon was almost impossible but in one case the presence of a spring salmon, *Oncorhynchus tschawytscha*, was determined by means of its scales. It is not unlikely that this was the predominant salmon taken as it is the species probably occurring in greatest abundance off the west coast of Vancouver Island at this time of the year. The squid was not identified.

The information regarding the sex, age and locality is that supplied by the Indian sealer to the collector.

No. 75, female in pup, 5-year old, 28 miles off Raphael Point, Flores Island, June 5. Food: herring, 75 per cent; salmon, 25 per cent; one small crustacean (*Ligyda pallasii*).

No. 76, female in pup, large, 20 miles south of Lennard Island Light, June 5. Food: herring, 95 per cent; salmon, 5 per cent.

No. 77, female in pup, 5- or 6-years old, 22 miles south of Lennard Island Light, June 5. Food: herring, 95 per cent; one small squid; numbers of small crustaceans (*Euphausidae*), 1 per cent.

No. 78, female in pup, 20 miles south of Sea Otter Rock, June 6. Food: herring, at least six individuals.

No. 79, male, 2- or 3-years old, 25 miles south of Lennard Island Light, June 6. Food: salmon.

No. 80, male, 3-year old, 25 miles south of Lennard Island Light, June 6. Food: salmon, hake, squid (25 per cent).

No. 81, male, 2-year old, 25 miles south of Lennard Island Light, June 6. Food: herring.

No. 82, female, not in pup, 3- or 4-year old, 25 miles south of Lennard Island Light, June 12. Food: two salmon, one a spring salmon, the other could not be identified.

No. 83, female, 4-year old, 25 miles southeast of Lennard Island Light, June 12. Food: herring; squid (20 per cent).

No. 84, female in pup, 5-year old, 25 miles southeast of Lennard Island Light, June 12. Food: herring; two small squids (15 per cent).

No. 85, female in pup, 5- or 6-year old, 25 miles south of Lennard Island Light, June 12. Food: herring; squid (15 per cent).

No. 86, female in pup, 5- or 6-year old, 25 miles south of Lennard Island Light, June 12. Food: herring, probably 75 per cent; pilchard, probably 25 per cent.

No. 87, female, 2- or 3-year old, 20 miles south of Wreck Bay, June 12. Food: herring; beak of small squid.

No. 88, male, 3- or 4-year old, 25 miles south of Lennard Island Light, June 18. Food: salmon, about 65 per cent; herring, 25 per cent; one small squid, 10 per cent.

No. 89, male, 4-year old, 15 miles south of Lennard Island Light, June 20. Food: herring.

No. 90, female not in pup, 3-year old, 22 miles south of Lennard Island Light, June 20. Food: salmon, 90 per cent; herring, 10 per cent.

No. 91, female not in pup, 4- or 5-year old, 25 miles south of Lennard Island Light, June 20. Food: herring.

No. 92, male, 2-year old, 22 miles southeast of Lennard Island Light, June 20. Food: herring.

No. 93, female, 5- or 6-year old, 25 miles southeast of Lennard Island Light, June 20. Food: pilchards.

No. 94, female, 5- or 6-year old, 25 miles south of Lennard Island Light, July 1. Foods: pilchards; one salmon vertebra.

No. 95, female, 5- or 6-year old, 20 miles south of Lennard Island Light. July 1. Food: pilchards, 80 per cent; one cottoid fish.

No. 96, male, 4- or 5-year old, 22 miles south of Lennard Island Light, July 1. Food: pilchards, at least six.

No. 97, female in pup, 4- or 5-year old, 28 miles south of Lennard Island Light, July 1. Food: pilchards.

No. 98, male (age not recorded), 20 miles south of Lennard Island Light, July 7. Food: herring, 35 per cent; salmon, 15 per cent; six squid, 50 per cent.

No. 99, female, 3-year old; 20 miles south of Lennard Island Light, July 7. Food: herring, 95 per cent; one osmerid fish; several small crustaceans (*Euphausidae*).

The collector, Mr. M. MacLeod, Fishery Inspector, reports that fifteen other stomachs were opened, of which at least six contained small amounts of herring or pilchards or both, and salmon, but the others were empty or practically so. The Indians state that unless the seals are killed outright, the stomach contents are disgorged.

The number of times of occurrence of the important food items is shown as follows:

Herring	occurred in	17	individuals, or	68 per cent
Salmon	occurred in	9	individuals, or	36 per cent
Squid	occurred in	8	individuals, or	32 per cent
Pilchards	occurred in	6	individuals, or	24 per cent
Hake	occurred in	1	individual, or	4 per cent
Cottoid	occurred in	1	individual, or	4 per cent
Osmerid	occurred in	1	individual, or	4 per cent

It is evident that the schooling species form the bulk of the food of these seals, no doubt because of abundance and ease of capture. The number of stomachs is too small to justify inference that the various species listed always occur in the relative abundance shown above, but it can reasonably be concluded that herring undoubtedly form the most important food material and that salmon constitute an appreciable portion of the food (about one-sixth of total food by bulk in all stomachs examined, as is shown by the first table), although they do not form the sole or even the main item.

Pacific Biological Station, Nanaimo, British Columbia.

MATERNAL BEHAVIOR IN THE DEER MOUSE

By R. R. Huestis

[*Plate* 3]

Personal care of 150 litters of *Peromyscus maniculatus* during the present year has brought particularly to my attention some features of maternal behavior that I believe to be worth recording. The routine involved a segregation of pregnant females in individual cages, each being supplied with a piece of absorbent cotton for nest material. Typically, the expectant mother immediately builds a nest and, as a rule, successfully rears a brood. The brood is examined shortly after birth, and the number in the litter recorded. A subsequent examination is usually made prior to the removal of the young from the mother when they are four or five weeks of age.

The possession of a young brood changes in a marked way the females' reaction to exploratory lifting of the nesting material. Mice of either sex will ordinarily rapidly evacuate a nest that is touched, but females with recently born young tend to remain within it. Some females sit stolidly upon the brood. Others make what might be anthropomorphically described as anxious or repelling movements with head and forepaws or attempt to bite exploratory instruments. Underlying individual differences in behavior is typically a pronounced reluctance to uncover the brood. Judging by the undisturbed appearance of the floor sawdust and the outside of the nest itself, I am of the opinion that females with young broods spend practically all their time in the nest with them.

Mother mice spread themselves over the young in what might be described as a hovering position. They cover the young in the same manner when deprived of all nesting material, so the posture, illustrated in pl. 3, fig. 1, is not merely a consequence of being in a nest. Occasionally a female with a half grown brood may be observed outside the nest and hovering her young even when they are not nursing.

Mother mice often, although not always, close the entrance to the nest when they are within it. Closure of the entrance may sometimes be due to the sagging of the fluffed cotton over the door after the mother has entered, but it is often possible to see a well defined plug of cotton in the entrance not quite flush with the outside margin of the nest. Some females plug up the small door between the feeding and nesting compart-

incidental to her movements. The hold upon its abdomen appears to induce postural reflexes in the young so that its body curves at each end toward the mother's head and out of harm's way.[1]

University of Oregon, Eugene, Oreg.

OBSERVATIONS ON THE YOUNG OF CAVE-DWELLING BATS

By Charles E. Mohr

On December 24, 1931, accompanied by my brother, John L. Mohr, I visited Nickajack Cave, Tennessee, and on January 4, 1932, Nickajack Cave, Tennessee, and Saltpetre Cave, near Rogersville, Alabama. In both of these caves we found *Myotis sodalis* to be the common wintering bat rather than *M. grisescens*, as I already have reported (1932, pp. 272–273). Later, on the same trip, we explored Dixon Cave, near Mammoth Cave, Kentucky, and Wyandotte Cave, Indiana, and observed the large colonies of *M. sodalis* which occurred there at the time. At each place we were told that the bats occupied the cave throughout the year.

Where *M. sodalis* occurs in Pennsylvania, however, particularly at Penn's Cave, all bats leave the caves during the summer. Accordingly it was with special interest that we revisited these caves and explored several others between June 26 and July 1, 1932. The trip was made at that particular season in the hope of taking the young of several species, since during the previous two weeks, at the Reading Museum, we had taken newly-born young of *Myotis lucifugus lucifugus*, *Eptesicus fuscus fuscus* and *Lasiurus cinereus*. Poole (1932a, pp. 25–27; 1926, pp. 364–367) has reported at length on the young of the last-named species.

Corynorhinus rafinesquii rafinesquii

Our first stop was made at Burke's Garden, in southwestern Virginia, where Howell (1909, p. 68) on August 7, 1908, found 10 or 15 specimens of *Corynorhinus rafinesquii rafinesquii* in one of the small caves that occur in the valley. The floor of the "garden" is 3200 feet above sea level, and the little valley, five by ten miles in extent, is completely surrounded by mountains, many of which rise to an

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[1] Svihla, A., A comparative life history study of the mice of the genus Peromyscus. Misc. Publ. 24, Univ. Michigan Mus. Zool., p. 13. Records clutching of mother, by older mice, while being carried.

altitude of nearly 5000 feet. We found this species in the fifth cave we visited, a large cave located on the Cassell farm at the southwestern end of the valley. The cave can be entered through either of two shallow depressions in an open field in the foothills of the mountains. It is believed to be quite extensive, but we did not explore it for any great distance.

As we entered the cave we heard the bats, and we came upon them about 50 yards from the entrance, hanging from the ceiling in two clusters of 30 to 50 bats each. They were very much excited by our approach. The mass of bats appeared to be completely encircled by long, quivering ears, and quite a few had been in the air before we sighted the groups. Most of the bats flew when we set off a flash bulb; the rest when we attempted to pick them from the ceiling. We found two young bats hanging from the spot where the adults had been and these were taken.

Three bats were caught on a gill net which we spanned across a narrow side passage. Each carried a single young. The bats were flying back and forth in the main passage so I fired a light .410 gauge shot-gun as two flew overhead. I missed the bats, but they were so stunned by the concussion that they flew around in circles and we picked them out of the air.

I have since fired at bats other than *Corynorhinus* in caves, under apparently identical circumstances, without interfering with their flight in any way. Apparently the ears of *Corynorhinus* are more efficient amplifiers than the smaller ones of our other bats.

Hearing the loud cries of a bat we followed them to their source and found a half-grown individual on the floor of the cave, uninjured. It probably had been dropped by one of the females at which I fired. This was the largest immature bat we found. This bat, a female, was prepared in the field but comparison of its body weight with that of the smaller young which were weighed indicates an approximate weight of four grams. Adults averaged nine to eleven grams. The measurements of this young bat were: head and body, 44 mm.; tail, 21; tibia, 15; foot, 9; forearm, 29; thumb, 5; ear from crown, 15; tragus, 8. The extent of the wings was 155 mm., just half that of the average adult. The body was thickly covered with short silky hair, Ridgway's hair-brown on the back, ecru-drab below.

Several bats were captured or shot as they came to rest on the walls or ceiling of the cave. Among them were two mature males, and one gravid female containing a fetus weighing 2.6 grams. The smallest young bat was approximately .5 gram heavier than this but already had its eyes open, indicating, I believe, an age of at least two days. Accordingly it is probable that the fetus would have been born within a day or two.

Two of the youngest bats, together with several females, were shipped to Reading alive. There Poole made the following observation on the call of one of the young: "It has a ventriloquial hollow *cuc-cuc-cuc*, like a yellow-billed cuckoo; close at hand a high thin *tse-tse-tse*, like the song of a blackpoll warbler, which could be heard synchronized with the other sound." These young on their arrival at Reading were weighed, the male being 3.1, the female 3.72 grams. Both were covered with very short, fine, silky hair.

Myotis grisescens

Our next stop was at Indian Cave, Grainger County, Tennessee, a large electrically lighted cave near the Holston River, north of Knoxville. Here a large

colony of *M. grisescens* occupied a small chamber leading off from the roof of the main cave quite close to the entrance. We found the bats hanging in compact masses, several thousand individuals by conservative estimate. The bats, disturbed by our lights, descended from the roof of the small chamber by hundreds, flying against us and against each other in the greatest confusion. The masses of bats diminished in thickness but not in extent, for apparently nearly every departing bat left a young one hanging in its place. Probably five per cent of the adults carried their young, one each, and these heavily-laden bats frequently dropped fluttering to the floor. I believe that under ordinary circumstances, however, these bats could satisfactorily carry a single young bat.

Some of the immature bats were old enough to fly; all had their eyes open, but the youngest were completely without hair. The largest were probably about three weeks old. The proprietor of the cave said that for more than two weeks he had been cleaning up young bats "by the shovel-full" from the floor of the cave. These bats supposedly dropped from their mothers, which may carry them for a week or more after birth. I doubt whether, in the gregarious species, the young are carried longer than this, rather, I am inclined to believe, for a considerably shorter time.

The proprietor of the cave believed that the bats occupied the cave throughout the year, but said that in winter they were to be found in a different part. I considered this a significant observation in light of conditions which I have found elsewhere and which I will enlarge upon later.

We handled several hundred individuals of *M. grisescens* and while no exact count was made, I am certain that less than ten per cent of the bats were mature males. A considerable series of young examined at random showed about two males to one female.

The smallest immature bat weighed 2.5, the largest 5.37 grams. The former was completely naked; the latter had a heavy covering of hair, practically identical on the back with that of the young of *Corynorhinus*, a hair-brown; it was drab below. All the adults taken or seen were in the russet phase. All the specimens collected were females. At Nickajack, in January, we took three males, all in the gray phase. The weight of the adults in June ranged from 7.64 to 9.1 grams; in January from 6.47 to 7.20 grams.

Next we went to Nickajack Cave, the type locality of *M. grisescens*. Here we found this species lining the ceiling in great numbers, the young remaining there as the adults flew. A count of a series of young bats in this cave showed 22 males and the same number of females.

Myotis sodalis

A search through the portion of Nickajack Cave where *M. sodalis* occurred during the winter did not reveal a single bat.

We visited Dixon Cave on June 28, and where thousands of bats had lined the ceiling in rows and clusters in midwinter, our only discovery was a tightly-bunched group of 69 male *M. sodalis*. They were secured and examined; all seemed rather torpid. No bats were seen in Mammoth Cave or in Crystal Cave, although they occur there in winter.

On the two days following we visited Wyandotte Cave, type locality of *M.*

sodalis, and Saltpetre Cave, nearby. This species occurs commonly in both caves in winter. We did not find a single bat hanging in either cave. I shot a male *Eptesicus fuscus fuscus* which was flying just inside the entrance of Wyandotte Cave, about ten o'clock at night. Two other bats, apparently *Pipistrellus*, were flying at the same time but I was unable to hit them.

Myotis lucifugus lucifugus

While I do not know that parturition in *M. lucifugus* occurs in caves, this species so commonly frequents caves that I feel that a note on the young may reasonably be included here.

The bats under consideration came from a colony of about 500 individuals, which occupy the spaces under the clapboards that cover an old log house near Kempton, in northern Berks County, Pennsylvania.

The colony was first discovered early in June and a series of observations was then begun. The bats were captured by stretching gill netting at a distance of about a foot from the most frequently used openings. The edges of the netting were fastened to the wall of the house with thumbtacks.

On July 16 several pregnant females were taken to the Museum and the following day two of them had each given birth to single young, weighing 1.45 and 1.55 grams. Both young seemed normal in every respect. Several others were born on succeeding days. The young were quite active, but nursed for only a short period of time, frequently deserting the mother and hanging alone a short distance away. On the second day the eyes of the larger of the two were open. Attempts to feed them with a medicine dropper were unsuccessful. The mothers evidenced little interest in the young, which, as they became weak, apparently from lack of nourishment, were killed and preserved.

Unfortunately, observations of parturition were usually of short duration and frequently interrupted. In two cases the females rested upon horizontal screening; in another case the bat hung from a vertical screen, head up, the young bat being supported partly by the pouched interfemoral membrane and partly by the umbilical cord, which was not severed, in several cases at least, but remained attached to the placenta when that was shed. The placentas dried and apparently broke off from the umbilicus on the second day.

The largest fetus, taken on July 5, weighed 1.38 grams, indicating that parturition was near. A large number of bats were collected on this date, but no young were taken on the wing, although bats could be heard crawling inside the wall after most if not all of the adults had left. At no time were females found carrying the young upon leaving the house.

The next observation was made on July 18, when 68 young bats, 35 male and 33 female, were taken on the wing. The immature bats were easily distinguished from the adults by the darker coloration, a sooty gray above, lacking the yellowish tinge below; by the thicker finger bones and swollen epiphyses; and upon closer examination by the milk dentition and the lighter weight, which on that date ranged from 4.7 to 5.4 grams. In summer the adults range in weight from 6 to 7.5 grams.

SUMMARY

Corynorhinus rafinesquii rafinesquii occurs in breeding colonies at the eastern-most point in its known range. The young are born from about June 15 to 30. The young, one in every case observed, are often carried by the mother, but are sometimes left hanging to the roof of the cave.

Myotis grisescens occurs commonly in the caves along the Tennessee River system in summer, and in winter is probably replaced in these caves by *M. sodalis*. The winter range of *M. grisescens* is not known. The young are born from about June 5 to 25. The young, in most cases one, are carried for only the first few days; thereafter they hang to the ceiling except while nursing.

A single colony of *Myotis lucifugus lucifugus* contained individuals born as early as June 17 and later than July 5. Young bats were on the wing within from three to four weeks after birth. The adults were never observed to carry their young. All pregnant females examined contained a single fetus.

Myotis sodalis is a common wintering species, though somewhat local, from Vermont to Alabama and from the Alleghenies to the Mississippi. Its summer range is unknown. The colony of males in Dixon Cave, Kentucky, apparently constitutes the first record of cave habitation at this season, although solitary individuals have been taken in August, probably the forerunners of bats returning to hibernation.

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Reading Public Museum and Art Gallery, Reading, Pennsylvania.

A NEW RACE OF SNOWSHOE RABBIT FROM CALIFORNIA

By Robert T. Orr

During my study of the Leporidae of California the presence of a heretofore unnamed race of *Lepus washingtonii* has become apparent. This constitutes the third race to be recognized of this Pacific Coast species.

Lepus washingtonii tahoensis, subsp. nov.

SIERRA NEVADA SNOWSHOE RABBIT

Type.—Adult female, skull and skin; no. 38286, Mus. Vert. Zool.; one-half mile south of Tahoe Tavern, Placer County, California; May 7, 1927; collected by James Moffitt; original no. M 24.

Diagnosis.—In general similar to *Lepus washingtonii klamathensis*, but in summer pelage mass effect of color darker; subterminal bands on overhairs darker, and black tipping of hairs more pronounced; rump patch conspicuously blackish as contrasted with *L. w. klamathensis* which is more or less uniformly colored dorsally. Skull differs from that of *L. klamathensis* as follows: zygomatic breadth less; brain case broader posteriorly; diameter of external auditory meatus greater; palatal bridge considerably longer, with a more prominent postero-median spinous process.

Measurements.—Average and extreme body measurements, in millimeters, of a series of seven adults from Placer County, California, are as follows: Total length, 384 mm. (363–396); tail vertebrae, 28.5 (25–37); hind foot, 120.1 (112–129); ear from crown, 96.5 (92–101). For cranial measurements see accompanying table, which also makes possible comparisons with *klamathensis*.

Distribution.—From vicinity of Lassen Peak southward along Sierra Nevada almost to Yosemite region. Niagara Creek, Tuolumne County, is most southern known station of occurrence. Zonal range, high Transition and Canadian. Altitudinal range, from 4800 to 7000 feet.

Remarks.—The existence of a race of snowshoe rabbit restricted to the Sierra Nevada has long been suspected, but sufficient material representing typical *L. w. klamathensis* and the central Sierran form has until late years been lacking. Through the courtesy of the officials of the United States National Museum the writer has been able to examine three topotypes of *L. klamathensis* from Fort Klamath, Oregon. Study of these and of seven specimens in the collection of the Museum of Vertebrate Zoology from southern Oregon and extreme northern California have demonstrated a marked difference to exist between them and the series of snowshoe rabbits from the central Sierra Nevada. Nelson (N. Amer. Fauna, no. 29, 1909, p. 109) remarked that one specimen from Donner, Placer County, was darker and more cinnamon rufous on the back and head than the Klamath specimens he studied. Only two skins from the Sierran area were at his disposal at the time he wrote, and one of these was in white winter pelage.

Two specimens from the vicinity of McCloud P. O., one from Siskiyou County and the other from Shasta County, are almost intermediate between the two forms

TABLE I

Comparative cranial measurements, in millimeters, of Lepus washingtonii klamathensis and L. w. tahoensis

NUMBER, MUS. VERT. ZOOL.	SEX	LOCALITY	BASILAR LENGTH OF HENSEL	ZYGOMATIC WIDTH	GREATEST LENGTH OF NASALS	GREATEST COMBINED WIDTH OF NASALS	ALVEOLAR LENGTH OF UPPER MOLAR SERIES	DIAMETER OF EXTERNAL AUDITORY MEATUS	WIDTH OF BRAIN CASE MEASURED FROM INNER SIDE OF EXTERNAL AUDITORY MEATUS	LEAST LENGTH OF PALATAL BRIDGE
92249*	♂	Fort Klamath, Ore.	55.4	36.3		15.3	12.7	4.5	22.4	5.2
18909*	♀	Fort Klamath, Ore.		37.8	29.3	16.2	13.5			4.4
53314	♀	Klamath County, Ore.	56.9	37.0	31.0	15.9	13.9	3.9	23.5	5.3
13759	♂	Bear Creek, Trinity Co., Calif.	52.9	36.4	28.4	15.0	13.2	4.4	22.9	4.9
31714	♀	Benton Estate, Siskiyou Co., Calif.	54.0		28.0	14.4	12.9	4.3	22.3	4.9
33081	♂	Weaverville, Trinity Co., Calif.		35.3	25.6	14.5	12.2	4.0		5.3
Average			54.8	36.6	28.5	15.2	13.1	4.2	22.8	5.0
37489	♂	Near Tahoe City, Placer Co., Calif.	53.6	36.2	27.0	15.6	12.6	4.8		6.1
38290	♂	Near Tahoe City, Placer Co., Calif.	55.0	36.4	28.4	15.4	12.5	5.3	23.8	6.4
37522	♂	Near Tahoe City, Placer Co., Calif.	54.3	36.3	27.0	14.6	13.0	4.8	23.6	6.3
23649	♂	Near Tahoe City, Placer Co., Calif.	55.5	35.9	28.5	15.4	13.2	4.9	23.2	5.7
21433	♂	Near Tahoe City, Placer Co., Calif.	54.3	35.4	27.6	14.1	12.3	5.1	23.5	6.3
36585	♀	Near Tahoe City, Placer Co., Calif.	55.8	34.3	29.4	14.5	13.0	4.9		6.2
38286	♀	Near Tahoe City, Placer Co., Calif.	56.0	36.4	27.5	15.4	13.3	5.0	23.6	6.8
Average			54.9	35.8	27.9	15.0	12.8	5.0	23.5	6.3

* U. S. National Museum.

here compared as regards the palatal character, coming slightly nearer *klamathensis*. Both are in late winter pelage, but one (dated March 30) is in process of molt, with a small patch of summer pelage present on the mid-dorsal area. This, however, lacks the darker coloration of *tahoensis* and seems to warrant placing it with the more northern race.

Six of the series of topotypes from the northwest side of Lake Tahoe are adults in, or approximately in, full summer pelage.

Specimens examined.—A total of 28 *L. w. tahoensis* in collection of Museum of Vertebrate Zoölogy, from following localities in California: Tehama County: Mineral (vicinity), 3. Plumas County: Willow Lake, 5600 feet, 1. Sierra County: east side Yuba Pass, 6000 feet, 1. Nevada County: Spruce, 1; ten miles west Truckee, 1. Placer County: Truckee, 1; Donner Summit, 1; Cisco, 1; near Tahoe City, 17. Alpine County: Pacific Valley, between Woodfords and Big Trees, 1.

Museum of Vertebrate Zoölogy, University of California, Berkeley.

AN UNDESCRIBED HIGH-MOUNTAIN GOPHER (THOMOMYS) FROM SOUTHERN NEVADA

By William Henry Burt

A series of five pocket gophers, collected in the Sheep Mountains of southern Nevada and now in the Donald R. Dickey collection at the California Institute of Technology, represents a diminutive species distinct from the gophers inhabiting the lower regions surrounding the mountains and also from the high-mountain species now known from the Great Basin. The species may be known as

Thomomys phelleoecus[1] sp. nov.

SHEEP MOUNTAINS POCKET GOPHER

Type.—Breeding female, skull and skin; no. 15878, collection of Donald R. Dickey; Hidden Forest, Sheep Mountains, Clark County, Nevada; altitude 8500 feet; July 12, 1929; collected by W. H. Burt; original no. 2330.

Measurements of type.—Total length, 187 mm.; tail vertebrae, 55; hind foot, 25. *Skull:* condylobasilar length, 30.7; length of nasals, 10.7; zygomatic breadth, 20.3; mastoid breadth, 17.1; interorbital constriction, 6.0; alveolar length of maxillary tooth row, 7.1; width of rostrum, 7.1; extension of premaxillae posterior to nasals, 2.3.

Distribution.—Known only from the type locality where it occurs on rocky hillsides and in canyon bottoms in yellow pine and fir associations.

Characters.—A small-sized *Thomomys* with small ears and light, smoothly rounded skull. Color of type (worn pelage except for top of head): upperparts

[1] φελλεύς, stony ground.

dusky "cinnamon-buff" (colors in quotations from Ridgway, Color Standards and Color Nomenclature, 1912) with much of the dark basal color of the hairs showing through, due to wear; underparts washed with yellowish; feet and tail whitish; post-auricular black patch distinct and relatively large (somewhat obscure where winter pelage still covers ear region); cheek border of mouth, "fuscous-black."

The color is somewhat variable in the five specimens available. Two adult females taken at the same time as the type have less of the dark basal color showing through and the general coloration is somewhat paler and brighter because of the less worn pelage. An immature female collected September 17, 1930, has the juvenile pelage replaced, except on the rump, by the first adult pelage which is even brighter than that of the two just mentioned. An immature male collected September 18, 1930, has the gray juvenile pelage except for the top of the head where the new pelage is similar to that of the type.

Skull small with rounded (inflated) braincase; nasals short; interparietal large and angular in shape (no. 15851 has the interparietal divided along the median line); occipital condyles well forward with respect to the supraoccipital; bullae rounded (globular); dentition weak; zygomatic arches rounded, tapering anteriorly.

Comparisons.—Thomomys phelleoecus differs from *Thomomys scapterus* Elliot in the following respects: size smaller, the average body length of three adult females of *phelleoecus* being 128 mm. as compared with an average body length of 149 mm. in three adult females of *scapterus*; foot smaller; ear smaller; coloration paler with a yellowish rather than a brownish cast; cheek border of mouth darker, blackish instead of dusky brown; skull smaller; nasals longer; no indication of an interparietal fontanel; occipital condyles less backward-projecting; when the skull is placed on end, resting on condyles and supraoccipital, it tends to fall forward in *phelleoecus*, backward in *scapterus;* dentition weaker.

From *Thomomys oreoecus* Burt, *phelleoecus* differs as follows: size slightly smaller; hind foot smaller; ear smaller; coloration, especially about the mouth, darker; skull smaller; nasals shorter and less deeply notched at posterior termination; rostrum narrower; projection of premaxillaries beyond posterior termination of nasals greater; interparietal larger and more angular in outline; bullae less globular.

As compared with *Thomomys providentialis* Grinnell, *phelleoecus* differs in the following respects: external characters similar except for the black post-auricular patch, which is more pronounced in *phelleoecus* in fresh pelage; general coloration slightly darker; skull smaller; nasals shorter; interparietal relatively larger, more nearly square; occipital condyles less backward-projecting; zygomatic arches more nearly parallel-sided.

Differs from *Thomomys bottae nanus* Hall in darker coloration of upperparts, slightly smaller size, less squarely built skull with broader nasals posteriorly, more inflated brain case, larger incisors, and less backward projection of condyles.

Remarks.—The affinities of *Thomomys phelleoecus* are clearly with the other mountain forms, *scapterus, providentialis,* and *oreoecus* from California and not with the low desert form, *centralis,* which occurs about the base of the Sheep Mountains.

California Institute of Technology, Pasadena, California.

THE MUSKRAT, ONDATRA ZIBETHICA (LINNAEUS), IN EUROPE

By Erna Mohr

[Manuscript translated by Mabel P. Hollister]

For more than one and one-half decades the muskrat, starting out from Bohemia, has been a middle-European calamity; the literature about it is extensive and scattered.

According to the report of the present Forest and Domain Director, K. Waschatko, who with his own hands set out the first muskrats, Prince Colleredo-Mannsfeld in the spring of 1905 brought back from a hunting trip to Alaska three pairs of muskrats, of which a male died on the way. So altogether there were three females and two males set out in Dobrisch, about 40 km. southwest of Prague in two little natural ponds, and fed at first with carrots and potatoes. The animals began soon after to build winter quarters. In a nest accidentally exposed were found sixteen young, probably of two litters. In the second fall many muskrats were to be seen in the vicinity of Dobrisch; after cleaning out one of the ponds in which they had been set out, Waschatko shot 31 of the animals in a short time. Already at that time they did much damage to the pond embankments of the neighboring farms, thus causing many useless lawsuits.

While according to Waschatko's report the animals came from Alaska, that is, from northwestern North America, in the literature it is generally stated that they originally came from southeastern Canada or Ohio. Some years ago the firm Carl Hagenbeck delivered some muskrats to Colloredo-Mannsfeld, of which the probable place of origin was stated to be Canada. In southeastern Canada the typical form (*Ondatra zibethica zibethica*) is native, and in the literature the middle-European rat passes for this form. The Alaska race is *Ondatra z. zalopha*. It is therefore entirely possible that besides the different hybrids we have here both original forms. Up to the present time, however, no one has occupied himself with the question of the slightly differentiated forms of our muskrats.

The European muskrat generally has two litters yearly, in favorable seasons three; as many as five litters a year are said to occur. The number of young in a litter varies from four to thirteen, seven being the average. The first litter in the spring is said to contain usually only from three to five young.

From 1905 to 1914 the whole of Bohemia was colonized by the muskrat. The animals wander much and far, and any region can be colonized, but the density of colonization varies so much that here and there the species may even be absent. At the time of the actual immigration and for a couple of years after that the animals are usually the most numerous; the territory of distribution is in general most thickly populated at the periphery, and it may be for a time entirely rat free in the interior, which, nevertheless may later be colonized anew. In Bohemia up to 1913 the radius of expansion amounted to from four to thirty kilometers yearly. The Bavarian boundary was first crossed by the animals in the district of the Regen River. This place is about 140 kilometers, as the crow flies, distant from Dobrisch. In the years 1923–24 in Bavaria the rate of migration is said to have amounted to from 50 to 70 kilometers yearly. In order to control this spread there is now undertaken in Bavaria a boundary marking experiment. The rate of the migration depends upon different factors, especially upon whether the colonizing starts from only one source or from several simultaneously. Flat country is more rapidly overrun than mountains, well-watered regions faster than those with little water, districts thickly peopled by man slower than those less settled.

In the year 1914, nine years after their planting in Dobrisch, the number in Bohemia was estimated at two million. At present, 1930, there are already the following lands infested (mainly, according to Toldt): Upper Palatinate and Lower Bavaria (Bavaria, Germany), as well as Lower Austria, since 1914; Upper Austria and Moravia (Austria) from 1915 on; Free State of Saxony (Germany) from 1917 (alleged, but not officially reported from 1913–14); Thuringia (Germany) from 1919; Province of Saxony (Prussia, Germany) from 1922; Bundesland, Vienna, Austria, from 1922 to 1923 (isolated cases), from 1924 regularly; Hungary from 1924 (a single case in 1922); in Prussian Silesia from 1924; from that point by this time Czech Silesia must also have been invaded; in Bundesland, Salzburg and in the Burgenland (both Austrian) from 1925 (in Burgenland a single case in 1915 and 1923). In addition an isolated report comes from Styria (Austria) from 1924. In 1927 parts of Middle and Lower Franconia (Bavaria) were settled, and in 1928 three cases from Brandenburg (Prussia) were reported. In all the places here listed muskrats are certainly meant. But from all parts there are sent in to the research stations as muskrats the most remarkable animals, in the hope of receiving the bounty prize. In Silesia even a dormouse (*Glis glis*) was thus sent in. I myself received in Hamburg,

almost 300 km. west of the nearest point of occurrence, several water rats (*Arvicola scherman*), Norway rats (*Rattus norvegicus*), and even shrews (*Sorex araneus*), all sent as muskrats.

Up to the present time the muskrat has pushed forward farthest to the southeast, about 420 km. down the Danube into Hungary; it has gone the shortest distance to the northeast, namely only about 200 km. into the Glatzer Mountains.

So far in middle Europe the following river drainages have been colonized: The Elbe from the source to Magdeburg; the Danube from Ingolstadt out over Gran into Hungary; the Oder, a single case; the Weser, especially in the source river Werra, 1921; the Rhine, in the tributary Main. The colonized territory extends from about 47° to 52° N and 10° to 18° E, and embraces about 200,000 square km. In Thuringia (according to Toldt) there were killed:

1919	1 rat	1923	207 rats
1920	5 rats	1924	676 rats
1921	5 rats	1925	2,074 rats
1922	? rats	1926 (first half)	19,016 rats

The number of muskrats officially reported killed in Germany in 1928 amounts to 30,000. In Bavaria the number of animals captured in the year 1927 fell about 10,510 below that recorded for 1926. Also in Prussia the number has dwindled, in fact about 25 per cent. This was not as the result of an epidemic; it is to be traced entirely to the efficacy of the measures employed to fight the muskrat. Even though the hunters and fur dealers consider the extermination of the muskrat to be undesirable, still the animals make themselves so objectionable to the cultivated areas that rigorous measures have been ordered. More serious disasters thus far have been pretty well prevented through the established supervising service; but the repairing of the constant damage is very expensive. In the year 1927 alone in the little country of Thuringia there were caused through the activity of the muskrat alone the bursting of six dykes, the sinking of seven highways, and the undermining of a railway embankment. Also in the Free State of Saxony there were all sorts of damages. Through the bursting of a dam at Moritzburg there was caused a loss of 20,000 marks; and in Saxony alone in the year 1927 in 52 instances railway property was damaged. In some parts of Bavaria, however, where many of the dams and banks are built of stone instead of earth, the animals cannot do much harm.

The number of the officially active muskrat-catchers amounts for

Bavaria to 7, for the Free State of Saxony, 1, for the Province of Saxony (Prussia), 1, for the Province of Silesia (Prussia), 3, for Thuringia, 5. Besides there are for the Free State of Saxony 179 regularly employed catchers. The chief work of the muskrat catchers consists in bringing the further advance of the muskrat to a standstill, through a systematic fight along a definite line. After the rooting out of the advanced rat colonies, every over-stepping of the boundary must be prevented, and the boundary must be pushed back as far as possible. This system has been followed with very good results especially in Bavaria. Aside from the digging out and hunting, several traps have proved good for the work, namely a kind of weir-basket and the floating cask. The basket works on the principle that a muskrat swimming freely on the surface of the water immediately sinks from sight if it collides with an unexpected obstacle; therefore the trap is composed of a taut wire strung between stakes and a weel-like receptacle placed under it with an entrance hole pointing upward. The rat colliding with the taut wire disappears immediately into the basket, does not find the opening again, and drowns. In such a trap six to nine animals can be caught in one night. The swimming cask also works very simply. It is so held in balance by a frame work of planks that an opening of 15 to 20 cm. square lies on top. The cask is half filled with water. The animal falling or scrambling through the opening can not come out again and drowns.

A very much disputed question concerns the manner of nourishment of the muskrat in Europe. On the whole it must probably be said that besides the great majority of muskrats that live on plants, there are also isolated individuals that prefer an animal diet. Much that is charged against the muskrat has certainly been done by other animals, as well as by fish thieves, crayfish thieves, and pearl thieves. There are, however, a number of observations that without doubt prove the muskrat to be a fish thief. To these belong the photographs by Regierungsrat Dr. Pustet, valuable as documents in the conflict of opinions, which he has kindly placed at our disposal for this general report: Photographs of carp that were found in muskrat quarters, chewed up in typical rodent fashion. The fisherman and especially the fishculturist in the muskrat districts will have to keep a sharp watch on the rats and in case of necessity must take energetic measures. On the whole, in middle Europe it is as in America—the animal can be let alone in peace in regions far from cultivation, but the enormous wandering instinct leads it always into the plantations and the cultivated plains. There its presence can not be tolerated, although the danger in the course of time

has not proved so great as was feared in the beginning. Nevertheless sums necessary for the fighting and the repairing of the burrowing damages are incomparably much higher than the small profits to be obtained from fur and flesh. With us the meat is not eaten, being at most sold for dog food. The oft-repeated, wide-spread opinion that the skin of the European muskrat is entirely inferior, is false. It may have been based on the fact that at first principally the skins of young animals and the summer pelts were brought to the market. Good European skins are valued by the fur dealer about as are those from the southern states of North America.

It is a little-known fact that the muskrat was also introduced in three places in Finland: in 1922 in Kronoby near the city Wasa, and in 1923 in Ylivieska (Uleaborg Län) and Tuulois (Tavastehus Län). From here, in the region of many lakes, the animals spread out yearly from 30 to 40 km., and the trappers intentionally aid their wider distribution. In recent years there were a couple of thousand animals captured and sold for five to seven gold marks apiece for the skin, which in Finland is good in every respect. So far the benefit outweighs the damage in Finland.

The carrying out of a Russian plan to set out American muskrats in the Solovietski Islands in the western part of the White Sea might not be objectionable. And there might be nothing against the intended planting in western and eastern Siberia; it is merely a question whether the animals will respect the boundaries intended for them there better than they have done in Europe.

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THE ASIATIC GENUS EOMELLIVORA IN THE PLIOCENE OF CALIFORNIA

BY CHESTER STOCK and E. RAYMOND HALL

[*Plate* 4]

Despite our growing knowledge of the relationships of Pliocene faunas of Asia and North America, relatively few cases are on record in which a given mammalian genus has been found to occur in both continental areas. It is a matter of considerable interest therefore, to discover in the collections of fossil mammals obtained by the California Institute in the Kern River Pliocene deposits of California, a mustelid that resembles closely *Eomellivora wimani*, described by Zdansky from the red clays of the provinces of Honan and Shansi, China. Indeed, so similar are these two forms that an examination of our specimen, in the light of Zdansky's description and good illustrations of the Chinese material, makes it difficult to establish any very noteworthy differences on which to base a specific distinction.

Eomellivora cf. **wimani** Zdansky

Pl. 4, figs. A to E

Eomellivora wimani Zdansky, Palaeontologia Sinica, ser. C, vol. 2, fasc. 1, pp. 61–67, pl. 11, figs. 5 and 6, pl. 12, figs. 1 and 2. 1924.

Specimens examined.—No. 1210, Calif. Inst. Technology, Coll. Vert. Paleont. Right maxillary fragment with M^1, P^4, P^3, the alveoli of P^2, P^1, and the posterior wall of the alveolus of the canine. Left maxillary fragment with M^1, the protocone and two roots of P^4, and a considerable portion of P^3. See plate 4, figs. A and B. Two incisors and a canine tooth, No. 1216, Calif. Inst. Technology, Coll. Vert. Paleont., are referred to *Eomellivora*. These specimens were found at the locality where No. 1210 occurred and are presumed to belong to the same individual. See plate 4, figs. C to E.

Locality.—Kern River Pliocene deposits, Bakersfield Quadrangle, U. S. Geol.

Survey, NE. ¼ Sec. 26, T. 28 S., R. 28 E., Mt. Diablo Base and Mer., Kern County, California. Collector, E. R. Inglee.

Comparison.—In addition to the complete skull material of *Eomellivora* on which Zdansky based the description of this type, fragmentary remains from the Chinji and Dhok Pathan horizons of the Siwaliks have been tentatively assigned to this genus by Pilgrim,[1] but are representative of species distinct from *E. wimani*.

The two pieces of the maxillary, No. 1210, from the Kern River Pliocene deposits of California, fortunately retain most of the cheek-tooth dentition. Little, however, remains of the skull structure. The fragment of the right side shows the entire course of the ventral surface of the relatively large infraorbital canal. At the forward end of the canal the ventral surface is elevated somewhat over the apex of the antero-external root of P^4.

The anterior premolars are crowded, apparently slightly more so than in *Eomellivora wimani*. As in the latter, P^1 is a single-rooted tooth situated immediately behind the canine and to the antero-internal side of P^2. Less space appears to be present for this tooth in No. 1210 than in the second example of *E. wimani* figured by Zdansky. P^2, as judged from its alveolus was single-rooted. In the Chinese species this tooth is two-rooted, possessing, according to Zdansky, a very strong posterior root and a slender anterior fang. In No. 1210, P^2 evidently extended along the antero-external wall of P^3 for a greater distance than in *E. wimani*, reflecting again the more crowded position of the anterior premolars.

Considerable similarity prevails between the Californian specimen and *E. wimani* in the structural details of the crowns of P^3, P^4 and M^1. P^3 possesses a size and shape closely similar to that in the corresponding tooth of the Chinese species. As in that species the principal cusp is flanked in front and behind by a reduced basal cuspule. The principal cusp appears to descend farther in No. 1210 than in Zdansky's specimen, although in the illustration of this portion of the crown of P^3 in *E. wimani* the cusp may be somewhat foreshortened. In shape and size of tooth and prominence of protocone, P^4 is singularly like the corresponding tooth in the species described by Zdansky. The protocone extends well to the inner side of the paracone and is broadly connected with the latter.

The structure of M^1 is again remarkably similar to that in *E. wimani*. Outwardly the crown is extended relatively far beyond the paracone and metacone. These cusps are subdued, with the paracone distinctly more prominent than the metacone. The latter is situated close to the posterior edge of the tooth. The features of the inner half of the crown agree closely with those described by Zdansky for *E. wimani*. In No. 1210 the basin receiving in occlusion the hypoconid of M_1 appears to be a trifle deeper and broader than in the Chinese animal, but this may be due to greater wear of the occlusal surface in our specimen.

Two incisor teeth and a canine were collected at the locality in the Kern River beds where No. 1210 was found and these may represent the same individual, though the fragmentary state of No. 1210 does not permit us to ascribe these teeth definitely to the same individual. One of the specimens, shown in fig. E, is clearly I^3, while the other may represent the second upper incisor. The latter (see fig. D), is slightly larger than the corresponding tooth in *E. wimani*.

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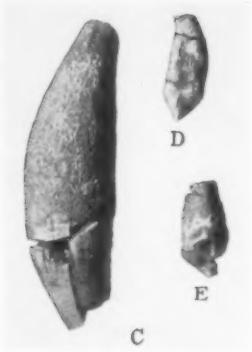
[1] Pilgrim, Guy E., Palaeontologia Indica, n.s., vol. 18, pp. 67–72, pl. 3, figs. 3–7a, 1932.



Eomellivora cf. wimani Zdansky. A, fragments of palate with cheek-teeth in occlusal view; B, right maxillary fragment and cheek-teeth in side view; No. 1210; C, upper (?) canine; D, I^{2}?; E, I^{3}; No. 1216. Calif. Inst. Technology, Coll. Vert. Paleont. Kern River Pliocene deposits, California. All figures natural size.

Remarks.—We do not maintain that the specimen from the Kern River Pliocene is specifically identical with *Eomellivora wimani*. Indeed, because of the wide geographic separation of the localities of occurrence, the Californian animal, if known by more complete materials than are now available, would doubtless be found to be specifically distinct. In fact, some difference is suggested by the more crowded anterior premolars, the single-rooted P^2, and the apparently higher principal cusp in P^3 in the Californian material. Although doubt may be expressed as to the specific identity of the American and Asiatic forms there can be but little, if any, question concerning the generic agreement.

The occurrence of this genus in both California and China furnishes another instance of close relationship between Pliocene Carnivora of North America and Asia like that found among the bears of the *Indarctos* group.[2]

Measurements.—The similarity in size between the Kern River material and the two specimens of *Eomellivora wimani* described by Zdansky from the provinces of Honan and Shansi may be appreciated by referring to the following measurements of the teeth.

Comparative measurements (in millimeters)

	EOMELLIVORA CF. WIMANI NO. 1216 C.I.T.	EOMELLIVORA CF. WIMANI NO. 1210 C.I.T.	EOMELLIVORA WIMANI* EXAMPLE 1	EOMELLIVORA WIMANI* EXAMPLE 2
I^2?, Length	6.4		5.4	5.8
I^2?, Breadth	4.1		3.2	3.1
I^3, Length	8.7		8.5	9.3
I^3, Breadth	6.9		6.1	6.5
C^1?, Length	14.0		12.0	12.3
C^1?, Breadth	10.2		10.2	10.6
P^3, Length		14.2	14.2	14.3
P^3, Breadth		10.1	10.1	10.6
P^4, Length		21.0	21.6	21.6
P^4, Breadth		16.0	15.1	16.7
M^1, Length		12.1	11.6	12.3
M^1, Breadth		19.9	20.1	20.5

* Measurements after Zdansky, p. 63, 1924.

Balch Graduate School of the Geological Sciences, California Institute of Technology, and Museum of Vertebrate Zoology, University of California, Berkeley, California.

[2] Merriam, J. C., C. Stock, and C. L. Moody, Univ. Calif. Publ., Bull. Dept. Geol., vol. 10, no. 7, 1916.

SYMMETRICAL SUPERNUMERARY MAMMAE IN A CHIMPANZEE

By Harold J. Coolidge, Jr.

[*Plate 5*]

In February, 1925, the skin and skeleton of a wild-killed female chimpanzee, taken near Sakbayeme in the Cameroons, were sent to the Museum of Comparative Zoology by the Reverend George Schwab. At the time the animal was captured, it was accompanied by a young one which escaped. A notation by Mr. Schwab on the label of the specimen queried the existence of an extra nipple. This hide, when returned from the tanner, was discovered to present a case of symmetrical supernumerary nipples. The skin has been unavoidably shrunken by tanning and the nipples may not, therefore, be in their true relation to the midline. As may be seen in the accompanying illustration (pl. 5), the accessory nipples are placed below, but a little outside, of the line of the normal nipples. They are situated on the milk line and their exact position can be only approximately determined by measurement on the dried skin. The normal nipples are situated 45 mm. from the midline. The left accessory nipple is 56 mm. from the midline, and 65 mm. below the normal nipple on the same side. The right accessory nipple lies 59 mm. from the midline, and 49 mm. below the normal nipple on the same side. The diameter of the normal nipple at the base measures 11.8 mm. and the length 10.2 mm. The left accessory nipple measures, base 8.2 mm., length 2.4 mm.; the right one, base 7.7, length 1.1 mm. The two normal and the left accessory possess terminal pores and were probably functional. The right accessory nipple is discolored like the others, but appears to have been distinctly smaller and probably non-functional. In this chimpanzee we appear to have a clear case of polythelia rather than polymastia owing to the pectoral position of the accessory nipples.

Records of polymastia and polythelia are frequent in man, but the asymmetrical outnumber the symmetrical ones. Also the left side is affected more often than the right. This whole problem is excellently summed up with a good bibliography in an article entitled "A case of supernumerary nipple in Macacus rhesus with remarks upon the biology of polymastia and polythelia" by Carl G. Hartman in this journal for May, 1927 (volume 8, p. 98).

As far as I have been able to discover, this is the second recorded

SKIN OF A CHIMPANZEE, SHOWING SUPERNUMERARY MAMMAE

case of multiple nipples in the anthropoid apes, and the first case of symmetrical ones. The first record was by Robert Owen (1868, vol. 3, p. 780), who stated: "In an Orang-utan (*Pithecus satyrus*), I have observed an accessory nipple on the left side, below the normal one and of smaller size."

Even as far back as the time of Geoffroy Saint-Hilaire, it was recognised that in man only one accessory nipple was found in the majority of cases of polymastia. Also statistics show that in the preponderance of cases this occurs on the left side. Hartman calls attention to the fact that this is "in accord with the common observation that the left breast is normally the larger and gives the more milk." Also that "accessory structures usually occur below the normal mamma in European women (over 90 per cent, Leichtenstern)" but above it in Japanese (82 per cent, Imai). For the above reasons it is interesting to note that while the chimpanzee nipples show the rather unusual symmetrical condition, they are situated below the normal nipples and the left one is the most highly developed, thus corresponding with the condition in man. Hartman also says: "It is significant that if the accessory nipple is situated below the normal it is found mediad; if above laterad to the normal mamma. It is thus usually on the normal milk line." The case he described in a "*Macacus rhesus*" conformed to this rule, but ours does not. By measurement both nipples are slightly laterad to the normal mammae. This may be on account of a slightly abnormal milk line, or on account of the way the skin has been shrunken. In any case the measurement of 11 mm. or 14 mm. is probably not great enough to be of any important significance and does not make this a case of a mammary gland outside the milk line.

If we accept Hartman's conservative guess that the phenomenon of accessory nipples appears in one per cent of human cases, it is interesting that in all the hides of great anthropoid apes in existence in the museums of the world, only two cases seem to have been recorded. This might be explained on the grounds that they may have been observed, but not recorded. However, most of the early papers on the great apes and many of those published today are by anatomists who would hardly have overlooked such a matter. The author has personally examined the hides of over six hundred specimens and this is the first and only case of supernumerary nipples that he has observed.

Museum of Comparative Zoology, Harvard College, Cambridge, Mass.

CORRECTIONS TO "A DIET FOR CHIMPANZEES AND MONKEYS IN CAPTIVITY"

By O. L. Tinklepaugh

In the above entitled article published in this Journal, Vol. 12, No. 4, 1931, inexcusable errors, made by the author and his assistants, were incorporated in the tabular analyses. Corrections are published herewith with the addition of the gram-colorie content of the baked chimcracker.

TABLE 1

Chimcracker formula and analysis

INGREDIENTS	GRAMS	PER CENT	PROTEIN		CARBOHYDRATE		FAT	
			Grams	Calories	Grams	Calories	Grams	Calories
Graham flour	1,200	12.0	159.6	638.4	856.8	3,427.2	26.4	237.6
Cracked wheat	2,200	22.1	244.2	976.8	1,661.0	6,644.0	37.4	336.6
Corn meal	2,200	22.1	202.4	809.6	1,658.8	6,635.2	41.8	376.2
Oatmeal	1,000	10.0	161.0	644.0	675.0	2,700.0	72.0	648.0
Whole milk, pwd	400	4.0	107.0	428.0	152.0	608.0	112.0	1,008.0
Peanut butter	1,200	12.0	351.6	1,406.4	205.2	820.8	558.0	5,022.0
Raisins (ground)	920	9.2	23.9	95.6	700.1	2,800.4	30.4	273.6
Molasses (dark)	455	4.6	10.9	43.6	315.3	1,261.2		
Bone ash	350	3.5						
Table salt	50	0.5						
Total	9,975	100.0	1,260.6	5,042.4	6,224.2	24,896.8	878.0	7,902.0

Total calories	37,841.2
Protein calories	5,042.4 or 13.3%
Carbohydrate calories	24,896.8 or 65.8%
Fat calories	7,902.0 or 20.9%
Calories per gram after loss of 3.9% water content during baking	3.95*

* In baking, as determined by Dr. C. F. Jacobsen, total water loss is greater than the amount added in mixing ingredients.

TABLE 2

Analysis of daily supplements per animal

MATERIAL	GRAMS	PROTEIN		CARBOHYDRATE		FAT	
		Grams	Calories	Grams	Calories	Grams	Calories
Cabbage, EP*	150	2.4	9.6	8.4	33.6	0.5	4.5
Carrots, EP	175	1.9	7.6	16.3	65.2	0.7	6.3
Onions, EP	125	2.0	8.0	12.4	49.6	0.4	3.6
Bananas, AP‡	300	2.4	9.6	42.9	171.6	1.2	10.8
Orange, AP	230	1.4	5.6	19.6	78.4	0.2	1.8
Apple, AP	200	0.6	2.4	21.6	86.4	0.6	5.4
Whole milk powder†	50	13.4	53.6	19.0	76.0	14.0	126.0
Peanuts, AP	114	22.2	88.8	21.1	84.4	33.2	298.8
Total	1,344	46.3	185.2	161.3	645.2	50.8	457.2

* EP, edible portion. ‡ AP, as purchased.

† One fourth cup whole milk powder to which one cup of water was added.

Total calories	1,287.6
Protein calories	185.2 or 14.4
Carbohydrate calories	645.2 or 50.1
Fat	457.2 or 35.5
Calories per gram	0.96

TABLE 3

Daily food per chimpanzee (average weight 22 kilos)

FOOD	GRAMS	PROTEIN CALORIES	CARBOHYDRATE CALORIES	FAT CALORIES
Chimcracker	350	184	910	289
Supplements	1,344	185	645	457
Total	1,694	369	1,555	746

Total calories	2,670
Protein calories in per cent	13.8
Carbohydrate calories in per cent	58.2
Fat calories in per cent	27.9

Laboratories of Comparative Psychobiology, Yale University.

GENERAL NOTES

GRAY LONG-TAILED SHREW FROM NEW HAMPSHIRE

A specimen of *Sorex dispar* taken on Mt. Washington, New Hampshire, on August 21, 1932, is apparently the first record for the state.

It was identified as referable to *Sorex dispar* by H. H. T. Jackson, who stated: "It does not differ in color from typical specimens of that species, and although it is smaller than average *S. dispar*, it is a young individual, and that may account for the difference in size. There is, of course, the other alternative, that the specimen may indicate an approach toward *S. gaspensis*. Intergradation between the two forms is to be expected."

The specimen (No. 97420, Am. Mus. Nat. Hist.) was taken in a moss-covered depression under which flowed the outlet of Upper Hermit Lake, in Tuckerman's Ravine, at an altitude of about 3850 feet.—Deane W. Mather, *American Museum of Natural History, New York.*

NOTIOSOREX IN ARIZONA

In the spring of 1931, during the course of ecological studies in the Chiricahua Mountains of southeastern Arizona, a single specimen of *Notiosorex crawfordi crawfordi* was obtained.

The shrew was taken at an elevation of 6500 feet in Pinery Canyon, on the west slope of the mountain, and was presented by a resident, who had kept the animal as a dried specimen. The skull was removed for identification and is deposited in the Division of Mammals, Museum of Zoology, University of Michigan.

Contrary to many accounts of the habitat of the gray shrew, the specimen was taken in the loamy soil of a cultivated field, less than two hundred feet from a permanent supply of water.

Dr. Walter P. Taylor, of the U. S. Biological Survey at the University of Arizona, informs me that the present record is the first recorded occurrence of this shrew in Arizona.—Philip M. Blossom, *Museum of Zoology, University of Michigan.*

OCCURRENCE OF THE LEAST WEASEL NEAR DENVER

On June the twenty-eighth, 1932, while in Denver, I called at Jonas Brothers Taxidermy Studio. Among other things of interest there Guy Jonas showed me a Least Weasel (*Mustela rixosa*) that was killed by a dog in a north part of Denver city on an open lot, on the third day of April, 1932.

It was a male, in full winter plumage, pure white, not a trace of black hairs even on the tip of its tiny tail.

This may be set down as a perfectly safe record for the species in Denver.—Ernest Thompson Seton, *Santa Fe, New Mexico.*

SEA OTTERS IN THE ALEUTIAN ISLANDS

The sea otter like several others of our most valuable wild animals was hunted nearly to the verge of extinction before drastic law enforcement enabled the few survivors to remain in existence. At the present time there are still very few of these animals but they seem to be on the increase in a few localities. From infor-

mation gathered from fishermen and natives I have learned that they are frequently seen along the coasts of Afognak Island. When I was there in 1922 I saw three or four of them swimming about amongst the kelp. One of the inhabitants had two skins in his possession which he claimed to have taken before the law prohibiting the possession or sale of sea otter skins went into effect.

In July, 1932, while engaged in botanical explorations on various islands of the Aleutian chain, I spent two weeks on Atka Island, and there learned that sea otters are becoming quite common in the Western Aleutians. Among the dangerous windswept foggy islets and reefs between Atka and Adak Islands, more properly known as the Sitkin Islands, sea otters can nearly always be seen if the weather permits. Vast kelp beds indicate a rich and ample supply of food for the sea otters. Dangerous currents, and sunken or exposed reefs in uncharted seas that are never still, afford protection and refuge.

Natives of Atka who own fox farms on some of the islands told me that they always go to their islands in company and heavily armed for fear of attack by Japanese poachers. These are generally commanded by a white man. I met an English captain of a Japanese poaching vessel in Kobe in October, 1930. Shortly before, he had been wrecked on Attu Island in the winter and had nearly died of starvation.

It is easy enough for poachers to work the Western Aleutians and evade the laws, because there are no inhabitants on most of the islands, and they are rarely visited by anyone. Within a distance of nearly 1200 miles by boat between Unalaska Island and Attu Island there are only about 300 inhabitants. The coast guard cutters make one or two trips from Unalaska to Attu during the summer and then take time only to stop a few hours at Atka, Kanaga, and Attu villages.

While collecting plants at King Cove, Alaska peninsula, in August I reported the abundance of sea otters in the Sitkin Islands to the captain of the "Crane" of the U. S. Bureau of Fisheries. A week afterwards he sailed out to those islands, and upon my return to Unalaska in September he told me that he had counted upwards of 40 sea otters between Adak and Atka Islands although the weather was unusually stormy at that time.

Residents of the Sanakh Islands told me that sea otters are also seen again quite frequently, amongst the kelp beds and reefs of those islands. Formerly this was one of the best localities for these animals.

The fact that there are many sea otters amongst the Sitkin Islands again ought to be an inducement to our government to try to capture a couple of dozen pairs to transplant at the Pribilofs or at some favorable locality where they can be guaranteed full protection.—WALTER J. EYERDAM, *9253 Corliss Ave., Seattle, Washington.*

ON THE INDOCHINESE GIBBONS (HYLOBATES CONCOLOR)

I have observed the gibbons of Indo-China (*Hylobates concolor*) in their natural surroundings on many occasions. Except in the deforested areas and northeastern Tonkin the morning calls of gibbons have been heard at all my camps.

These animals live in primeval forests, always on trees, and I believe they never come to the ground. They live in small parties, probably families, of five to ten; there are usually two or three adult buff-colored females, and from four to six black individuals of different ages. Newly born young cling to their mother's breast. They are generally distributed, but never very numerous. Indochinese

gibbons are very sedentary and very numerous, and if there are no imperious reasons, they will roam over only about one hundred acres at the most, as long as they have peace and food. They eat leaves and fruit mostly, with probably a few insects and eggs, but they seem to be less insectivorous and carnivorous than other species of gibbons.

They progress, like gymnasts, by means of their long and powerful arms, and throw themselves from one branch to another for distances of thirty feet and more. No other monkeys can compete with them for ease and grace in their progression among trees. They play much like children, but usually clinging to branches. They will grasp tiny twigs, but before leaving their "point d'appui" they always make sure that the next hold is strong enough. When not too young, they almost never fall. They love hanging by one foot or hand, on a thin twig, and balancing. They often rest by lying down on their back on thick limbs of trees, and they take positions just like those of a man lying on a bed or on the ground. They also lie on the belly. They invariably sleep sitting on a branch, often a small one, at the top of a tree, several of them together and embracing one another very tightly with their arms.

Gibbons dislike water, except for drinking; this they generally do by dipping their hand and sucking it, but they can also drink by putting their lips into the water. This is especially true of young ones. If they fall into the water, they will swim to reach the nearest shore, but they never take to water willingly, and I have proved with captive animals kept at my home near Clères, France, that a ditch 3 meters wide, filled with water, is an obstacle that they will not cross.

Up to three or four years old, these gibbons have only short whistling notes and calls, when afraid or excited; it is only later that they begin to "sing;" the whole party then joins in a chorus. As far as I have been able to observe it, the females start by long ascending calls, repeated three or four times; their mates join in with cries of "*oua-ea-ouaee*...," higher and higher. This is finally taken up by the females, who end the song by shrill shrieks of "wee-wee-wee." During the second half of the performance, the animals, but more especially the females, jump about the tree in a frantic way. These "songs" are repeated at any time of the day, except during the extreme heat. They are most often heard in the early morning, and are utterly different from those of the *lar* gibbons.

Judging from my tame specimens, males always remain gentle and harmless, but adult females grow very spiteful to others and to young, and to other beings, including man. The sexes are equal in size.

My gibbons at liberty in France differ in no way in their behavior from their wild brothers in Indo-China. They stand all our winters out of doors (lowest record, − 11° centigrade). Some have lived at Clères since 1925. They have just become adult, and I hope they will breed shortly. In the beginning they were all tame and gentle, but the females, after about four years became quite savage, biting viciously, and had to be relegated to islands, where they have ever since lived happily. An old female is now so dangerous that one must take great care not to let her come near, when one goes to her island. Her male has remained as gentle and affectionate as ever.

Another female, too timid to attack human beings, proved spiteful to other female gibbons, killing two young ones that had been let out, by ripping them open with her long canine teeth. She bit some males severely, but did not try to

kill them. In France, my gibbons are fed with bread and milk, fruit, particularly dried figs, boiled carrots and potatoes, and salad. They eat many leaves and some insects at certain seasons. In close confinement, gibbons soon die, often of tuberculosis. They need at least a large open, out-door cage. Thus confined, they have done well in the Paris Zoo. Here they have good shelters, but remain in the open air all year round.

Only one gibbon of the *lar* group, *Hylobates lar pileatus*, is found in French Indo-China, in Cambodia, on the right bank of the Mekong. I obtained one near Khone, on the Cambodia-Laos border. That it occurs together with *H. concolor* I have no doubt, as I obtained specimens of the latter species near Angkor and observed several in different parts of Cambodia. Judging by their behavior in captivity, I should say that *lar* and *concolor* do not care much for one another, and take little notice of each other if kept in semi-liberty.—JEAN DELACOUR, *Clères, Seine-Inférieure, France.*

OCCURRENCE OF A GRAY SEAL AT ATLANTIC CITY, N. J.

A gray seal (*Halichoerus grypus*) was taken in the nets at Young's Million Dollar Pier, Atlantic City, New Jersey, following a severe northeast storm in March, 1931. This is apparently the first gray seal recorded on the American coast south of Sable Island, Nova Scotia. The limits of the range of the gray seal are not very definitely known, but it is undoubtedly restricted to the North Atlantic and, normally, Nova Scotia represents the southernmost limit of its range on the American coast. Its presence at Atlantic City, New Jersey, now attested by a specimen in the American Museum of Natural History, may be attributed to the severe weather prevailing at the time of its capture, or alternatively we may assume that during the winter months the gray seal has a much wider range than has hitherto been supposed. The specimen, when taken, showed no signs of extreme exhaustion but lived for a year afterwards in captivity.

The specimen is a young male from two to three years old and measures five feet seven and a quarter inches from nose to tip of tail. In general color it is warm buff, heavily mottled on the back with fuscous-black, most intense on mid-dorsal area and gradually fading on throat and chest to nearly clear dark warm buff on belly; hairs on back tipped with buffy and recurved; hind flippers fuscous-black; fore flippers paler; crown of head fuscous.—G. G. GOODWIN, *American Museum of Natural History, New York.*

NOTES ON THE LIFE HISTORY OF THE WOODRAT, NEOTOMA FLORIDANA RUBIDA BANGS

Although the woodrat (*Neotoma floridana rubida* Bangs) is one of the most common of the small mammals of southern Louisiana, very little has been published on its life habits. The following notes were made during the years 1925 to 1927 in the region south of Morgan City, Louisiana. This area is composed chiefly of marshland intersected by bayous. Tree islands occupy the slightly higher parts of the marshes, which occur usually along the bayou banks. These islands consist of palmetto, live oak, willow, and cypress, and here the nests of the woodrat may be found, piled up against fallen logs, the bases of trees, or even up in the branches. Most of the trappers' shacks, which are used only during the trapping season, are occupied by woodrats, and their nests of twigs, papers, and other débris

can be found piled upon the shelves or in the corners. The characteristic musky, sweet odor of these rats makes their presence unmistakable. Their well-known habit of packing any movable object accounts for the great variety of materials which make up their nests. However, the greater part of the nest material consists of whatever happens to be most abundant in the immediate vicinity, indicating perhaps a definite limit of range. For instance, nests built at the bases of palmetto trees are almost always made up of the hard, woody bases of the palmetto leaves. Nests built in trappers' shacks consist chiefly of débris left by the trapper and his family. The size of the nests varies from one and one-half to four feet in diameter and up to three feet in height. The materials are piled loosely, evidently just where the woodrat happened to drop them. At the base of the pile of material are the openings to the inner nest. The outer materials act as a protective covering to this inner nest, which is made up of finely shredded fibers of grass or other soft material.

Several pairs of woodrats were captured alive and kept under observation in captivity. They were easily caught in spring-floor traps set near their nests, using rolled oats as bait. The ordinary house rat (*Rattus norvegicus*) was also common in this locality, and at first glance it was difficult to distinguish them from the woodrats on account of the similarity of size, color, and comparative hairlessness of the tail. However, the long, curving whiskers of the woodrat and the distinct difference in reaction to capture of these two rodents soon enabled immediate recognition. The woodrats were always quiet and docile when trapped, while the house rats fought and bit the wires of the trap, keeping up a continuous squeaking in the meanwhile.

The woodrats were kept in large wire cages and provided with cotton, excelsior, and twigs with which to build nests. The material was carried with their teeth, usually one twig being picked up at a time, while the heavier pieces were dragged. Both sexes helped in building. They came out of their nests at dusk and worked busily all night with much scurrying and stamping of the feet. They would stamp with their hind feet whenever angry, surprised, or frightened, and would almost always respond when mimicked. They were by no means voiceless, for they made loud squeaking noises when fighting or angry. The young also squeaked on a higher pitch when dropped by the mother or left in the cold. Often the adults would make a chattering noise with their teeth very similar to the chatterings made by muskrats when nervous.

They were fed such grains as rice, wheat, corn, and rolled oats as well as breakfast cereals and green vegetables. All extra food, especially grains, was always stored in their nests. In storing, kernels of grain would be picked up in the fore paws one at a time and placed in the cheek pouches until they were filled. The rats would then scamper to the nest, where the grain was deposited. This was repeated until the feed pan was empty.

Although these woodrats were kept under observation throughout the year, no young were born except during the month of March. In five litters born in captivity, the number varied from 1 to 4, with 3 and 4 occurring most frequently. At birth the young were slightly hairy and darkly pigmented on the back, while the ventral surface is pink in color. The eyes and ears are closed, the latter having the pinnae folded over so that the openings are closed. Six young weighed from 10.5 to 14 grams at birth. The mammae in these rodents are in two pairs situated

close together in the inguinal region. It is surprising how tenaciously the young cling to the mammae, for only with difficulty are they made to relinquish their hold. This tenacious hold is brought about by an interesting morphological adaptation of the milk teeth in that the tips of the upper and lower incisors are spread apart so as to form a diamond shaped space between them. Into this space the elongated teats of the mother fit, and when the teeth are brought together they clamp down very securely upon the teat. Thus the harder the grip the more secure the hold and the firmer the attachment to the mother. This is of utmost value to the species, for if the mother is suddenly disturbed she is able to leave the nest very rapidly and can save her young by dragging them to safety.

It is regretted that circumstances prevented carrying this work to completion, but it is hoped that this ambition may be realized in the near future.—Arthur Svihla and Ruth Dowell Svihla, *Chas. R. Conner Museum, Pullman, Wash.*

TREE-CUTTING BY MUSKRATS?

The Honorable Kenneth A. Reid, of the Fish Commission, reports a very unusual occurrence on his estate on the outskirts of Connellsville, Pennsylvania.

Mr. Reid has planted in recent years about 15,000 young pine and spruce trees, several hundred of these being set around the shores of the small lake near his residence. Last spring something began cutting down several of these transplants each night, and examination showed every one severed with a clean diagonal cut, but a still more careful examination disclosed small tooth marks.

Suspecting muskrats, as he had seen two swimming in the lake the previous fall, Mr. Reid employed a local trapper, who promptly caught two muskrats. And although he had already lost a total of 41 trees in this way—mostly Norway spruce—not a tree has been molested since the muskrats were caught. Consequently the seemingly inevitable conclusion is that it was these muskrats that cut down the trees.

Every tree was removed the night it was cut down, and the only surmise so far is that the muskrats were gathering material for a "house," although if so, the animals were caught before their new house appeared above the surface.

It is also a puzzle why muskrats should have come to this little lake at all, as it had been drained for some years and only recently refilled, by the inflow of a small mountain brook, almost wholly falls, rising less than a mile above, and emptying through a thickly populated suburb of the city into a stream badly polluted from coal mines.

After this unusual experience with muskrats, Mr. Reid expresses his thankfulness that he has not yet had a demonstration of "what a nice healthy family of beaver would do to his young trees!"—Thomas E. Winecoff, *Pennsylvania Game Commission, Harrisburg, Pa.*

INTERFRONTAL—A HERITABLE CRANIAL VARIATION OF THE HOUSE MOUSE

The presence of an interfrontal bone has been noted in skulls of two strains of mice bred in the murarium of the Bussey Institution. In each case a slender additional bone separates the forward portion of the frontals. (See A, fig. I.) Posterior to the interfrontal bone the median suture between the frontals is normal.

A wild female house mouse bearing this interfrontal variation was captured in

a Boston residence. It was mated to a non-agouti silver male bearing the normal median suture. Four females and three males were produced, all normal with regard to the cranial anomaly. A pair of these hybrids gave rise to numerous progeny, seven males and one female of which were killed and examined for the character. The female and five males were normal, whereas two males possessed an interfrontal bone similar to that of their grandmother.

The character cannot be a dominant because it disappeared completely in the first generation. The second hybrid generation shows a perfect three-to-one ratio which is the re-combination proportion expected if the character is determined by a single pair of recessive Mendelizing genes.

Interfrontals and parted frontals[1] (erroneously described as parted parietals) have not yet been observed in the same individual. It may be suggested, however, that both characters ought to be expressed in the same animal without any unusual condition arising from the combination, because parted frontals (see X, figure 1) widen the median suture somewhat posterior to the position occupied by the interfrontal bone.—CLYDE E. KEELER, *Howe Laboratory, Harvard Medical School.*

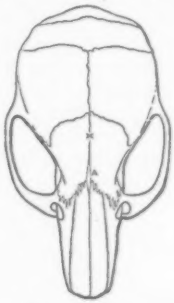


FIG. 1. SKULL OF HOUSE MOUSE, MUS MUSCULUS

A CANADA PORCUPINE FROM LAKE COUNTY, ILLINOIS

An adult female porcupine was killed by an automobile on April 19, 1932, on a side road three miles north of Barrington, in Lake county, Illinois. Through the kindness of Mr. Robert Freking, of that city, this specimen came into my hands. Dissection disclosed a single foetus, almost at term. The skins and skulls of mother and young are preserved in the Field Museum (nos. 38029–30).

Although this is the first authentic record of the occurrence of *Erethizon dorsatum dorsatum* in northern Illinois, it can hardly be accepted without substantiation, since that inveterate collector of odds and ends, the American tourist, may well have been instrumental in introducing this specimen from northern Wisconsin or Michigan. A careful examination, however, revealed none of the customary marks borne by a captive mammal.

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[1] Keeler, C. E. 1930. Journ. Heredity, vol. 21, no. 1, pp. 19–20.

Kennicott (The Quadrupeds of Illinois Injurious and Beneficial to the Farmer, 1858) writes of this form that he is "not aware that it has been observed in Northern Illinois, although it is said to inhabit Whiteside County and the banks of the Illinois River." Cory, who has given the most complete account of the history of this species in Wisconsin, Illinois and Indiana, writes (Mammals of Illinois and Wisconsin, 1912): "I have been informed that years ago it [the Canada porcupine] was occasionally found in Jo Daviess County, but upon investigation the evidence proved unsatisfactory. Nevertheless, Mr. Edward Grim of Galena writes me, he believes it was formerly found in that county. In Indiana, however, its range is known to have extended to the southern portion of the state, and it was apparently not uncommon in several of the extreme western counties in close proximity to Illinois. The Prince of Wied states that it was rare in Posey County at the time of his visit in 1832. Evermann and Butler cite numerous records for Indiana, the latest being a specimen taken in Grant County, in 1892; but Hahn believes that it probably survived along the Kankakee River a few years later. Mr. E. J. Chansler, of Bicknell, Indiana, writes me that old men told him that porcupines were common in Knox County in early days, and that Mr. T. E. Chambers saw one near Chambers Pond in that county in 1864. There are two specimens in the State Museum at Indianapolis claimed to have been taken in Laporte County, Indiana, but the date is not given. Dr. John T. Plummer states that several porcupines were killed in the suburbs of Richmond, Wayne County, Indiana, and that he had a fine specimen in his collection captured near that town."

From this it is apparent that at no time, so far as we know, has the porcupine been seen or captured in northern Illinois, although the former range of the species seems to have approached this region rather closely on several sides. It seems hardly reasonable to assume that a species as sluggish in its habits and as restricted to a timbered habitat as this is should suddenly appear a hundred and twenty-five miles south of its present range, by natural means. However, the record seems so interesting that it is given for what it may be worth.—D. Dwight Davis, *Field Museum of Natural History, Chicago, Illinois.*

THE VARYING HARE (LEPUS AMERICANUS VIRGINIANUS) IN CHANGING PELAGE

The following observations were made during an ascent of Camel's Hump, Vermont, one of the higher peaks of the Green Mountain range, on June 12, 1932.

Three individuals of this species were seen at close range at varying altitudes, and decided differences were noticeable in the pelage, even though the observer was unable to handle them or to have more than a limited time for observation.

The first hare, seen at an altitude of approximately 2800 feet, appeared to be in summer pelage. The second, noted at about 3200 feet in altitude, was noticeably lighter, especially about the rump and neck. The third sat for several minutes in in the path just a few feet ahead of us, showing a surprising absence of fear in comparison with the individuals seen earlier. In this individual, the neck and rump were quite white and the whole pelage was markedly lighter than in the others. This was near the summit of the mountain at an altitude of almost 4000 feet and close to timber line, where snow often persists into May.—Wendell P. Smith, *Wells River, Vermont.*

MORE ABOUT ELK CALLS

Mr. O. J. Murie's article on "Elk Calls" in the November, 1932 issue of the Journal of Mammalogy caused me to look up my notes on the voice of elk, these notes being made while I was detailed on a study of the northern Yellowstone elk herd.

On May 30, 1930, in the Pelican Creek Valley, I observed a young bull going through all the movements of elk courtship with three young cows. I was so close to these elk that one cow heard the buzzing of my DeVry motion picture camera and advanced to within thirty feet of the blind in which I was kneeling. For about 35 minutes all four elk were within 100 yards of my location and I heard bugling from the group three times. Twice I am positive it was the bull that bugled—the third time I was not sure but think it was the bull. The call was similar to the mature bull's call in the fall except that the coarse notes at the end were omitted.

Spring bugling has been heard by me on May 12, 20, and 30; June 4 and 5. Fall bugling from September 8 to November 6.

I also have some notes on behavior of elk while being handled for shipment, ear tagging, or getting blood samples for study. Only old cows voice their anger or fright. I have never heard the bulls, young or old, utter any noise except gritting of teeth, although bulls are necessarily handled somewhat more roughly than the cows. Even when their antlers are being sawed off, preparatory to crating and shipping, the bulls keep silent, although they express their anger by striking with front feet, kicking extremely viciously with hind feet, and gritting of teeth. Cows give voice to their angry "barks" frequently while being handled in the corral and hustled along the loading chute. The electric prod-pole used at Yellowstone Park caused the old cows to emit some rather queer noises which perhaps expressed a mingled surprise and anger. Slitting of the end of the tail to get a blood sample does not cause the cows to "bark."

In eastern Montana and northern Wyoming the practice of hunters using a call to attract bull elk to within rifle range is apparently not in vogue, but in western Montana and northern Idaho, according to reliable local residents, it is a regular practice amongst hunters and guides and is quite successful. With the use of a call made of an elder stem the bugle can be imitated closely enough to cause a bull to come crashing through the brush to within easy shooting distance. The Flathead Indians are adept in using this call and I have heard them practicing in their tepees preliminary to a hunt.

This habit of the bull to respond to the imitation call would indicate that the call at this time of the year was in the nature of a challenge. The elk hunting season begins on October 5 in Idaho and on October 15 in Montana.—W. M. Rush, *Forest Service, Missoula, Mont.*

REPORT OF THE WISENT RESERVE AT SPRINGE, HANOVER

Dr. Lutz Heck, the director of the Berlin Zoo, tells how in 1924 this institution proposed creating a wisent reserve and range outside of that city. In the mean time Director Schoenichen of the Staatliche Stelle für Naturdenkmalpflege in Prussia, became interested, and with the aid of the Ministry of Agriculture and Forestry the proposed wisent reserve has been practically carried out. The plans

of the buildings were made by the construction staff of the Zoo, according to sketches furnished by Dr. Heck. The construction itself was done by Forstmeister Maske, Chief Forester at Springe, and all the details of the care and feeding of the wisents were also furnished by the author. In 1928 the Springe inclosure, an area of about 17 acres, was detached from the original walled-in game park of the former kings of Hanover, which had an area of 3779 acres and is in a beautiful wooded and hilly country. On September 17, 1928, the Springe reserve was stocked with a pure blood wisent bull, 2 bison cows, a hybrid cow and a hybrid cow calf. Two sides of the reserve are formed by the old stone wall of the park and the remainder is inclosed by a strong double fence. There is a stable with four large stalls, so arranged that the animals can be fed separately, when necessary. All ditches and puddles in the reserve were filled in to prevent transmission of infection by water insects of any kind; fresh water for drinking is provided in troughs from a pump. We must now recapitulate as to the causes which led to the establishment of a "Verdrängungszucht" (breeding by a process of gradual elimination). On December 31, 1928, and December 31, 1929, there were in Europe 59 wisents alive, 27 bulls and 32 cows. On December 31, 1930, there were 61 wisents, 29 bulls and 32 cows—a very moderate increase indeed. Three methods of breeding to preserve the species come under consideration:

1. Pure family breeding, without worrying about inbreeding, the method pursued with success at the Berlin Zoo.

2. Breeding from two different lines: If, for instance, the Swedish wisent herd produces in time a particularly hardy stock, this could be crossed with the Berlin animals with good results. In 1907, Czar Nicolas presented Carl Hagenbeck with a first class Caucasus wisent bull and his progeny are spread over the whole European stock, so that at least one half of all wisents are related to him.

3. The "Verdrängungszucht," is a last desperate breeding method. It has, however, if properly carried out, the best prospects of success. First class wisent bulls are bred to bison cows, all male offspring is disposed of, and the females are bred further to wisent bulls; in three to five generations, outwardly the wisent type should prevail.

Dr. Heck also affirms that all the offspring of the "Verdrängungszucht" are most exactly entered in a special division of the wisent herdbook, so as to keep all the animals derived from crossbreeding, during long sequences of generations, separated from the pure blood wisents. In consideration of this care all practical objections to the Verdrängungszucht must disappear.

What gave the final blow to all hopes for starting a pure breed wisent state park was the fact that the first class pure blood wisent herd belonging to Herr von Beyme, Scharbow in Mecklenburg, and which he was negotiating selling to the State, developed cases of foot and mouth disease and perished in 1926. This was the last chance for the State to acquire a herd of pure breeds, and the funds which had been raised were directed to the Springe project. On June 12, 1929, the first calf, unfortunately a bull calf, was born, on July 15, 1929, a cow calf; the mothers in both cases were American bisons, the father was the above mentioned wisent bull. On May 22 and 24, 1930, two cow calves were born, and on June 3, a bull calf, which died; thus there remained two cow calves.

In 1931, two cow calves and one bull calf were born. Thus there are now 5

cow calves of the first generation, and soon the pure blood bison cows will be removed and the breeding by process of elimination proceeded with.

The herd is healthy, and there is every reason to hope that the results will be in every way satisfactory.

The following item may also be of interest: Since 1927, the Berlin Zoo under Dr. Heck's direction is preparing the solution of a breeding problem of the most important kind: the reconstruction of the ur or aurochs (*Bison primigenius*), formerly spread over Europe and extinct since the 17th century. According to the theories of the modern science of inheritance it is quite possible to rebreed the aurochs, characteristics of which are preserved in certain primitive races of domestic cattle.—THEODOR G. AHRENS, *Waitzstrasse 24, Berlin-Charlottenburg 4, Germany.*

RECENT LITERATURE

Akeley, Carl and **Mary L. Jobe.** LIONS, GORILLAS, AND THEIR NEIGHBORS. Pp. xviii, 260, pls. 21. Dodd, Mead & Co., New York, 1932. Cloth, $2.50.

In these hectic times, with the corresponding mad rush for notoriety regardless of the outcome, there seems to be an increasing number who desire to be authors and who choose some subject, or visit some locality, to secure glimmerings upon which to write a book. As a consequence such material, which often is based largely on rumors, hearsay, and the evolutions of a plastic imagination, is so obscured that subsequent travelers have some difficulty in determining from their own observations whether the place they are visiting is the same as the title of the book would seem to imply.

It is therefore a pleasant and interesting task to review a book when one knows that in it the truth has never been sacrified for mere thrills, or excitement, and that on all occasions the greatest care has been taken to present the facts as they occurred. Doubly pleasant it is when one has had long contact and warm personal friendship with the authors.

The book "Lions, Gorillas, and their Neighbors," gives us a wonderful amount of interesting detail in regard to things found in a country which as yet has not lost its luster through the corroding influences of so-called civilization. There is not a page but that is well worth the reading. Our ideas, gleaned from here, there, and elsewhere, touching on conditions, habits, or any details of this complicated subject, are likely to be corrected by the clear statements of conditions as found by our trained authors, who traveled through perils, hardships and privations in practically uncharted regions, where at times escape from fatal injury would seem impossible when all the facts are made known. Where will we find a man who would succeed in killing a full-grown leopard with his bare hands, as Carl did on one occasion? Mrs. Akeley furnishes facts to show that the lion is not an aggressive killer as some would picture him, but that he is quite a gentleman if treated as such, and seldom attacks humans if unprovoked.

Anthropologists, whose interests really belong to zoology, will also find much of value in the chapter on the "little people" and in other items scattered through the book. Mrs. Akeley gives a further interesting account of "Bill" who pre-

viously was given considerable attention by Carl in his "Adventures in the African Jungle." Here was a native boy who had a mind that with training reached a point of wonderful efficiency that enabled him to cope with conditions in all emergencies, including two occasions when he saved his master's life.

There are twelve chapters in the book: Four relating to lions, two to gorillas, and one each to wild dogs, buffalos, hippos, leopards, little people, and Bill.

A very commendable feature of the book is that on all occasions when assistance was given full credit has been acknowledged, which is so different from some authors who selfishly lose in the background those who have made important parts of the work possible.—A. K. Fisher.

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BURT, WILLIAM HENRY. Descriptions of heretofore unknown mammals from islands in the Gulf of California, Mexico. Trans. San Diego Soc. Nat. Hist., vol. 7, no. 16, pp. 161–182. October 31, 1932. (New: *Perognathus baileyi fornicatus, Perognathus penicillatus minimus, Perognathus spinatus guardiae, P. s. marcosensis, P. s. pullus, P. s. seorsus, P. s. latijugularis, Peromyscus sejugis, Peromyscus boylii glasselli, P. collatus, P. pseudocrinitus, P. caniceps, P. guardia mejiae, P. g. interparietalis, P. dickeyi, P. pembertoni, Neotoma varia, N. lepida marcosensis, N. l. latirostra* [*sic*], *N. bunkeri*.)

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CALDWELL, HARRY R. Native methods of tiger hunting in Fukien. China Journ., vol. 11, no. 1, p. 48. July, 1929. (Shooting with poisoned arrows.)

CHALMERS, PATRICK. The wolf in Britain. Field, London, vol. 156, no. 4057, p. 439, fig. 1. September 27, 1930.

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DYMOND, R. Grey squirrels and walnuts. Field, London, vol. 156, no. 4055, p. 379. September 13, 1930.

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FIGGINS, J. D. A proposed standard of viewpoints from which to illustrate horned and antlered mammal skulls. Proc. Colorado Mus. Nat. Hist., vol. 10, no. 3, p. 22, pls. 1–3. September 26, 1931.

FITZPATRICK, G. S. F. A bunch of baboons that were too much for a leopard. Field, London, vol. 156, no. 4061, p. 588, figs. 2. October 25, 1930.

FLEROV, K. K. Brief outline of the classification and geographical distribution of the reindeers or caribou of the Old World. Publ. Acad. Sci. URSS, Yakutsk ser., no. 4, Leningrad, pp. 1–15, figs. 13. 1932. (New: *Rangifer angustirostris.*)

FLYNN, T. THOMSON. The uterine cycle of pregnancy and pseudo-pregnancy as it is in the diprotodont marsupial *Bettongia cuniculus*. Proc. Linnaean Soc. New South Wales, vol. 55, pt. 5, no. 231, pp. 506–531. December 15, 1930.

———— A new species of fossil cetacean from Tasmania. Geol. Mag., vol. 69, no. 817, pp. 327–329. July, 1932. (New: *Prosqualodon davidi*: name actually dates from Dart, 1923, Proc. Zool. Soc. London, p. 638.)

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FRIANT, M. Une incisive déciduale d'éléphant anormalement développée. Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 3, no. 7, pp. 576–578, figs. 2. November, 1931.

FRIEDERICHS, HEINZ F. Schädel und Unterkiefer von Piltdown ("Eoanthropus dawsoni Woodward") in neuer Untersuchung. Zeitschr. f. Anat. u. Entwicklungs., Berlin, vol. 98, nos. 1–2, pp. 199–262, figs. 40. 1932. (New: *Boreopithecus* for *B. "dawsoni"* [= *vetus* Miller]. A new interpretation of the Piltdown remains. The skull fragments represent modern man, and the jaw represents a new genus of great apes most nearly related to *Pongo* and *Palaeopithecus*.)

FURLONG, EUSTACE L. A new genus of otter from the Pliocene of the northern Great Basin province. Contrib. to Paleont., Carnegie Inst. Washington Publ. 418, no. V, pp. 93–103, pls. 2. August 3, 1932. (New: *Lutravus; L. halli*.)

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GIBSON, M. H. Nutria farming in Argentina. Field, London, vol. 156, no. 4057, p. 447. September 27, 1930.

GILL, LORIN TARR. The rat that does not gnaw. Rare Hawaiian rodent long thought to be extinct. Nature Magazine, vol. 14, no. 5, pp. 278–280, figs. 4. November, 1929. (*Rattus hawaiiensis*.)

GOLDMAN, E. A. The jaguars of North America. Proc. Biol. Soc. Washington, vol. 45, pp. 143–146. September 9, 1932. (New: *Felis onca arizonensis*.)

——— A new pocket mouse from southern Arizona. Journ. Washington Acad. Sci., vol. 22, nos. 16–17, pp. 488–489. October 19, 1932. (New: *Perognathus amplus taylori*.)

GOODWIN, GEORGE G. Two new mammals from Guatemala. Amer. Mus. Novitates, no. 528, pp. 1–2. May 23, 1932. (New: *Sigmodon zanjonensis, Liomys anthonyi*.)

——— Three new *Reithrodontomys* and two new *Peromyscus* from Guatemala. Amer. Mus. Novitates, no. 560, pp. 1–5. September 16, 1932. (New: *Reithrodontomys mexicanus howelli, Reithrodontomys pacificus, Reithrodontomys gracilis anthonyi, Peromyscus guatemalensis tropicalis; P. grandis*.)

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GRAY, ROBERT W. Breeding habits of the Greenland whale. Nature, London, vol. 123, no. 3102, pp. 564–565. April 13, 1929.

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——— On the nature of size factors in mice. Amer. Nat., vol. 65, no. 700, pp. 406–416. September–October, 1931.

GREEN, ZIEGLER, DEWEY AND SHILLINGER. Epizootic fur encephalitis. I-II-III. Amer. Fur Breeder, vol. 4, no. 5, pp. 4–8. November, 1931; vol. 4, no. 6, pp. 4–8. December, 1931; vol. 4, no. 8, pp. 20–22. February, 1932.

GRINNELL, JOSEPH. A new lake-side pocket gopher from South-central California. Univ. Calif. Publ. Zool., vol. 38, no. 10, pp. 405–410, pl. 7. September 20, 1932. (New: *Thomomys bottae ingens.*)

GROSS, ALFRED O. A jungle laboratory. Companions of the wild at Barro Colorado Island. Nature Magazine, vol. 15, no. 1, pp. 11–15, figs. 19. January, 1930.

GYLDENSTOLPE, NILS. A new *Scapteromys* from Chaco Austral, Argentine. Arkiv. för Zoologi, vol. 24 B, no. 1, pp. 1–2. January 28, 1932. (New: *Scapteromys chacoënsis.*)

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——— A new weasel from Panama. Proc. Biol. Soc. Washington, vol. 45, pp. 139–140. September 9, 1932. (New: *Mustela frenata panamensis.*)

——— A new pocket gopher from New Mexico. Univ. Calif. Publ. Zool., vol. 38, no. 11, pp. 411–412. September 20, 1932. (New: *Thomomys baileyi tularosae.*)

——— and RAYMOND M. GILMORE. New mammals from St. Lawrence Island, Bering Sea, Alaska. Univ. Calif. Publ. Zool., vol. 38, no. 9, pp. 391–404, pls. 5–6, fig. 1. September 17, 1932. (New: *Sorex jacksoni, Citellus lyratus, Clethrionomys albiventer, Microtus innuitus punukensis.*)

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HARRIS, WILLIAM P., JR. Four new mammals from Costa Rica. Occas. Papers Mus. Zool., Univ. Michigan, no. 248, pp. 1–6. August 4, 1932. (New: *Sylvilagus dicei, Bassaricyon lasius, Heteromys oresterus, Oryzomys aphrastus.*)

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HAWEIS, STEPHEN. Why is a zoo? Concerning the place of caged animals in society. Nature Magazine, vol. 14, no. 3, pp. 146–150, figs. 8. September, 1929.

HERREN, W. H. A trek after tuskers. Outdoor Life, vol. 68, no. 6, pp. 22–23, 42–43, figs. 4. December, 1921.

HILLIARD, C. L. Bears on the Cariboo Range. Outdoor Life, vol. 68, no. 6, pp. 16–17, 51, figs. 5. December, 1931.

HIPGRAVE, ARTHUR. Grey squirrels. Field, London, vol. 156, no. 4059, pp. 517–518. October 11, 1930. (Damage wheat in England.)

HÖFLIGER, H. Haarkleid und Haut des Wildschweines. VII. Beitrag zur Anatomie von *Sus scrofa* L. und zum Domestikationsproblem. Zeitschr. f. Anat. u. Entwicklungs., vol. 96, pp. 551–623, 31 figs., 1931.

HOLZWORTH, JOHN M. "Mr. Hoots" of Admiralty Island. Outdoor Life, vol. 68, no. 1, pp. 12–13, 72–73, figs. 4. July, 1931; no. 2, pp. 26–27, 70, figs. figs. 3. August, 1931; no. 3, pp. 30–31, figs. 5. September, 1931. (Treats of grizzly and brown bears.)

HOME, W. DOUGLAS. A fine roebuck head. Field, London, vol. 156, no. 4056, p. 414, fig. 1. September 20, 1930.

HOPE, CLIFFORD E. Hoary bat at Toronto [Ontario] in summer. Canadian Field Nat., vol. 45, no. 6, p. 147, fig. 1. September, 1931. (*Lasiurus cinereus.*)

HORNADAY, WILLIAM T. Tapirs, so far as known. Bull. New York Zool. Soc., vol. 32, no. 2, pp. 43–53, figs. 10. March-April, 1929.

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HOWELL, ARTHUR H. Florida's mammals. Nature Magazine, vol. 14, no. 6, pp. 338–340, 378–379, figs. 9. December, 1929.

HURST, E. WESTON and J. L. PAWAN. An outbreak of rabies in Trinidad without history of bites, and with the symptoms of acute ascending myelitis. The Lancet, pp. 622–639. September 19, 1931. (During severe enzoötic in Brazil from 1908 to 1918, 30 per cent of horses and 15 per cent of cattle died of rabies. Cattle bitten by vampire bats afterwards developed rabies. Experimental investigation of bat caught biting cow confirmed supposition that it was a vector. Trinidad vampire bat *Desmodus rufus* may play similar rôle. Removal of herd of cattle from pasture to stall in Trinidad brings about cessation of epidemic. Lanterns are kept burning in stalls to scare away bats.)

HYER, EDWARD ALLAN. Mammals of the Lake States. Nature Magazine, vol. 15, no. 5, pp. 302–304, 340–341, figs. 12. May, 1930.

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KELLOGG, REMINGTON. New names for mammals proposed by Borowski in 1780 and 1781. Proc. Biol. Soc. Washington, vol. 45, pp. 147–148. September 9, 1932. (The name for the Humpback whale is now *Megaptera novaeangliae* (Borowski).)

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KLUGH, A. BROOKER. Presenting Blarina. Nature Magazine, vol. 15, no. 4, pp. 241–243, figs. 3. April, 1930. (*Blarina brevicauda.*)

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KOŽHANČHIKOV, I. V. Life of Martes zibellina in the Saian mountains and its geographical distribution. Comptes Rendus Acad. Sci. URSS, ser. A, no. 12, pp. 299–304. 1930. (Food habits and distribution; in Russian.)

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KRUMBIEGEL, INGO. Das sog. Kompensationsgesetz Goethes betr. Korrelation von Kopfwaffen und Oberzähnen. Zu Goethes 100 Todestag am 22. 3. 1932. Zeitschr. für Säugetierkunde, Berlin, vol. 6, no. 5, pp. 186–202, figs. 4, pl. 21, figs. 5–6. December 15, 1931.

KUZNECOV, B. Über eine neue Art der Pferdespringer (*Alactagulus shitkovi* n. sp.) aus Semiretschje. Comptes Rendus Acad. Sci. URSS, no. 23, pp. 623–626. 1930. (New: *Alactagulus shitkovi.*)

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LEECHMAN, DOUGLAS. Fleece-bearing dogs. Nature Magazine, vol. 14, no. 3, pp. 177–178, figs. 3. September, 1929.

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LUCAS, JOCELYN. Badgers and hunting. Field, London, vol. 156, no. 4060, p. 559. October 18, 1930. (Badger kills fox cubs.)

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NAGLER, L. B. A pugnacious rabbit. Outdoor Life, vol. 67, no. 4, p. 104, fig. 1. April, 1931.

NELSON, E. W. Remarks on coyotes, with description of a new subspecies from Salvador. Proc. Biol. Soc. Washington, vol. 45, pp. 223–226. November 26, 1932. (New: *Canis latrans dickeyi*.)

——— and E. A. GOLDMAN. Two new cacomistles from Mexico, with remarks on the genus Jentinkia. Journ. Washington Acad. Sci., vol. 22, nos. 15–16, pp. 484–488. October 19, 1932. (New: *Jentinkia sumichrasti campechensis*, *Bassariscus astutus consitus*.)

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——— De certaines particularités des Suides. Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 3, no. 7, pp. 570–575, figs. 5. November, 1931.

NOBACK, CHARLES V. The Zoological Park's young female gorilla, Janet Penserosa. With notes concerning her companion, a young female chimpanzee, Ellen Allegra. Bull. New York Zool. Soc., vol. 34, no. 3, pp. 75–104, figs. 42. May-June, 1931.

OAKLEY, RICHARD. Hyaenas in Somaliland. Field, London, vol. 156, no. 4061, p. 590. October 25, 1930.

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OSBORN, HENRY FAIRFIELD. The "Elephas meridionalis" stage arrives in America. Proc. Colorado Mus. Nat. Hist., vol. 11, no. 1, pp. 1–3, figs. 2. September 7, 1932. (New: *Archidiskodon meridionalis nebrascensis.*)

——— Trilophodon cooperi, sp. nov., of Dera Bugti, Baluchistan. Amer. Mus. Novitates no. 585, pp. 6, figs. 2. November 15, 1932. (New: *Trilophodon cooperi.*)

——— and WALTER GRANGER. Coryphodonts and uintatheres from the Mongolian expedition of 1930. Amer. Mus. Novitates no. 552, pp. 16, figs. 17. August 17, 1932. (New: *Hypercoryphodon, H. thomsoni; Gobiatherium, G. mirificum.*)

OSGOOD, WILFRED H. Mammals of the Kelley-Roosevelts and Delacour Asiatic expeditions. Field Mus. Nat. Hist., Publ. 312, Zool. Ser., vol. 18, no. 10, pp. 193–339, figs. 2, pls. 9–11. August 19, 1932. (New: *Pithecus delacouri, Macaca assamensis coolidgei, Triaenops whecleri, Myotis siligorensis alticraniatus, Discopus, Discopus denticulus, Neotetracus sinens..s fulvescens, Chodsigoa lowei, Belomys pearsoni blandus, Callosciurus erythraeus hendeei, Callosciurus flavimanus bolovensis, Dremomys pyrrhomerus gularis, Tamiops monticolus olivaceus, Typhlomys cinereus chapensis, Rattus indosinicus, Dacnomys millardi ingens, Vandeleuria dumeticola scandens, Eothenomys (Anteliomys) custos hintoni, Ochotona cansa stevensi, Muntiacus rooseveltorum.*)

OWEN, G. Martens in north Wales. Field, London, vol. 156, no. 4051, p. 243. August 16, 1930.

PACK, ARTHUR NEWTON. Sheep of Shovel Pass. Nature Magazine, vol. 17, no. 6, pp. 363–368, figs. 10. June, 1931. (In Jasper Park, Alberta.)

PAN, ISMAEL DEL. Notas paleogeográficas acerca del oso de las cavernas y del oso pardo. Mem. R. Soc. Españ. Hist. Nat., vol. 15, no. 1, pp. 425–426, 2 maps. 1929. (Cave bear and brown bear.)

PARKER-HUTCHINSON, G. G. Foxes and badgers sharing an earth. Field, London, vol. 156, no. 4050, p. 207. August, 1930.

PARTIK, C. R. Martes pennanti (fisher). I–II. Amer. Fur Breeder, vol. 4, no. 6, pp. 22–24. December, 1931; vol. 4, no. 7, p. 33. January, 1932.

PEDERSEN, ALWIN. Der Scoresbysund. Drei Jahre Forschungsreisen an der Ostküste Grönlands. Berlin: August Scherl, p. 157, figs. 56, map. 1. 1930. (Contains interesting photographs of narwhal.)

PEEL, C. V. A. Preserving the Norwegian reindeer. Field, London, vol. 156, no. 4046, p. 63. July 12, 1930.

PETERS, H. B. Ueber Naht-Anomalein und -Variationen am Primaten-Cranium. Zeitschr. f. Morphol. u. Anthropol., vol. 30, pp. 317–372, figs. 78, pls. 7. 1931.

PETERSON, O. A. New species from the Oligocene of the Unita. Ann. Carnegie Mus., vol. 21, no. 2, pp. 61–78, pl. 1. April, 1932. (New: *Epihippus intermedius, Heteraletes, H. leotanus, Mesamynodon, M. medius, Pentacemylus, P. progressus, Poabromylus, Poabromylus kayi.*)

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PICKWELL, GAYLE. Some forest sprites. Varieties of western chipmunks mean much to the outdoors. Nature Magazine, vol. 15, no. 6, pp. 359–362, figs. 9. June, 1930.

PINCUS, GREGORY. A modifier of piebald spotting in mice. Amer. Nat., vol. 65, no. 698, pp. 283–286. May–June, 1931.

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Felis ocreata vernayi, Leptailurus serval mababiensis, Lutra malculicollis chobiensis, Mellivora capensis vernayi, Ictonyx orangiae ghansiensis, I. striatus shortridgei, I. s. lancasteri, I. kalaharicus, I. kalaharicus nigricaudus, I. k. giganteus, Paraxerus cepapi chobiensis, P. c. maunensis, P. c. kalaharicus, Gerbillus calidus kalaharicus, Malacothrix typicus kalaharicus, M. t. damarensis, Steatomys krebsi kalaharicus, S. pratensis maunensis, Lemniscomys griselda fitzsimonsi, Lepus saxatilis bechuanae, L. s. ngamiensis, L. s. chobiensis, L. s. albaniensis, L. s. nigrescens, Lepus capensis vernayi, L. c. ermeloensis, L. c. hartsensis, L. c. langi, L. c. bedfordi, Neoromicia vansoni, Eptesicus capensis nkatiensis, Pipistrellus vernayi, Scoteinus schlieffeni fitzsimonsi, Choerephon (Lophomops) langi, Elephantulus intufi kalaharicus, Nasilio brachyrhynchus mababiensis, Papio porcarius ngamiensis, P. p. chobiensis, P. p. nigripes, Cercopithecus aethiops ngamiensis.)

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COMMENT AND NEWS

THE NINETEENTH AMERICAN GAME CONFERENCE

The Nineteenth American Game Conference met under the auspices of the American Game Association in New York City, November 28, 29 and 30, 1932. As usual the program concerned the game birds more than the mammals, but several interesting papers were presented on this latter group, among them an extensive report on the game situation in the West by Paul G. Redington, C. E. Rachford and Horace M. Albright, and a paper on the management of our deer herds by E. A. Goldman. Other papers on the mammals were, "Rearing Cottontail Rabbits for Restocking Purposes" by Charles A. Hiller; "The Ohio State Coon Farm" by James W. Stuber; and "Will Cat License Laws Save Wild Life?" by J. M. Loughborough. These papers will be published in the Proceedings of the American Game Conference and fuller report on them is thus unnecessary.

Twenty-four or more members of the American Society of Mammalogists were present at the meetings and many took an active part in the program and the meetings of related organizations which were held at that time. The corresponding secretary represented the Society at the Conference and at the meeting of the Game Policy Committee.

ANNOUNCEMENT OF ANNUAL MEETING

The fifteenth annual meeting of the American Society of Mammalogists will be held at the new Biological Institute, Harvard University, Cambridge, Massachusetts, from Tuesday, May 9, to Saturday, May 13, 1933. Titles and further particulars regarding papers for presentation should be in the hands of the Corresponding Secretary not later than April 21. Further details regarding the meeting may be obtained from the Corresponding Secretary, or from the Local Committee on Arrangements: Thomas Barbour, chairman; Glover M. Allen, Harold J. Coolidge, Fred H. Kennard, and John C. Phillips.

LOSS TO SOCIETY'S INCOME

During the past year there has been a loss in effective membership, because of resignations and delinquencies, of about two hundred and fifty. The Society has suffered further loss from default on payment of interest on a part of the investments of the Allen Memorial Fund. The consequent drop in the Society's resources makes it imperative, unless the income speedily can be brought back to normal, that the size of the quarterly numbers be drastically reduced. It is therefore urged that our members make every effort to pay all back dues promptly, and to obtain more members.